Dr. Wurf

THE AIR MAN

Looping the loop above New York

THE AIR MAN

HIS CONQUESTS IN PEACE AND WAR

BY

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ILLUSTRATED WITH PHOTOGRAPHS

NEW YORK
THE CENTURY CO.
1918

Published, July, 1917;
Second Edition June, 1918

TO

HENRY WOODHOUSE

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The heavens filled with argosies of magic sails;
Pilots of the purple twilight dropping down with
costly bales.

Tennyson.

THE AIR MAN

CHAPTER I

LEARNING TO FLY

ANY ONE who has common-sense and patience may learn to fly. In the aviation schools, a good working knowledge of airmanship is ordinarily gained in a total of four hundred minutes spent in the air, divided into a score of lessons. The air would almost seem the natural element of man, such has been the progress in flying during the past few years. With surprisingly little instruction, the average pupil soon learns to feel perfectly at home aloft. Many find it easier to support themselves in the air than in the water. Gravity is, of course, a very exacting taskmaster, but under competent instructors serious accidents to-day are almost unknown. The more daring feats of

airmanship, the loops and spirals practised in air duels, come, of course, only with long, persistent practice.

An instructor usually begins with a new pupil much as a mother-bird teaches her fledgling to fly; by encouraging it to hop about before spreading its wings. The first aëroplane used for instruction is often a worn-out machine that cannot possibly rise, known in the slang of the schools as a "taxi" or "lawn-mower." The beginner quickly becomes familiar with the motor and controls, and accustoms himself to the noise of the propellers when he is set running his craft up and down the aviation field. After he has learned to steer his aëroplane in a straight line, he is promoted and allowed to make short "hops." In some schools, control of the machine is taught in dummy aëroplanes resting in a stationary position.

The pupil is entrusted with a somewhat better machine in his next lessons. The "hops" do not lift the aëroplane more than five feet, but they give excellent practice in rising and landing, and enable the beginner to judge the ground. An accident may

Writing against the sky, an aëroplane traces the letters C A L (for California) by a series of loops

Miss Ruth Law flying above the Statue of Liberty

mean a smash, but the pilot at this height is comparatively safe. Progress is more rapid after this stage. In the next class a pupil is set to flying "straights" and learns to rise to a height of twenty-five or thirty feet, remaining in the air for half a mile. He is now set to flying in circles, going up three hundred or four hundred feet. His landing exercises play an important part in this instruction, and he is required to come down on a fixed mark. As the aviator gains confidence, the flights are made in the figure eight style, he is taught to land with his engine cut off, and other feats required of an air-pilot.

In the French system, the pupil is first taken aloft for several flights of five minutes each and taught details of control while in the air. After he has become familiar with the machine, he is allowed to handle the controls and work the pedals. The aëroplanes used for instruction are usually equipped with dual control, or with steering apparatus and engine connections in duplicate. The beginner holds these controls and his feet rest on pedals which duplicate every

movement made by the instructor. In a few hours the pupil learns to do the right thing almost instinctively; he is soon directing the machine aloft, while the instructor merely checks his movements. There are several systems of instruction employed to-day that variously combine these two methods.

Time may be measured in months rather than years since the spiral and loop were curiosities; while a pilot who attempted them was considered daring to the point of folly. Many lives were lost in attempting such flights. So rapid has been the advance in airmanship, however, that to-day these feats are required in the best schools of aviation. The air man who can descend from an altitude of á mile or more in a vertical spiral, describing an air-course like a corkscrew; or loop-the-loop, not once but several times in quick succession, is considered a safer pilot because of his skill for ordinary cross-country flights. Let him suddenly run into a storm, be tossed about by contrary air-currents, or find himself with a stalled engine at a great altitude, and his superior airmanship

makes him master of the situation. In aërial warfare, of course, the airman's life will depend on his skill in dodging an antagonist to gain a better position to bring his battery into action.

To obtain a license in America, the pilot must fly his machine before representatives of the Aëro Club.

The candidates must pass the following tests before being granted a certificate:

Spherical Balloon Pilot's Certificate

(A) Five ascensions without any conditions.

(B) An ascension of one hour's minimum duration undertaken by the candidate alone.

(C) A night ascension of two hours' minimum duration comprised between the setting and the rising of the sun.

Dirigible Balloon Pilot's Certificate

The candidates must be 21 years of age. They must hold a spherical balloon pilot's certificate and furnish proof of having made twenty (20) flights in a dirigible balloon at different dates, and must also undergo a

technical examination. In case, however, the candidate does not already possess a spherical balloon certificate, he must have made twenty-five (25) ascensions in dirigibles before he can apply for a certificate. The application for the certificate must be countersigned by two dirigible balloon pilots, who have been present at at least three of the departures and landings of the candidate.

Aviator's Certificate

1. Candidates must accomplish the three following tests, each being a separate flight:

A and B. Two distance flights, consisting of at least 5 kilometers (16,404 feet) each in a closed circuit, without touching the ground or water, the distance to be measured as described below.

C. One altitude flight, during which a height of at least 100 meters (328 feet) above the point of departure must be attained; the descent to be made from that height with the motor cut off. A barograph must be carried on the aëroplane in the altitude flight. The landing must be made in

view of the observers, without restarting the motor.

2. The candidate must be alone in the aircraft during the three tests.

3. Starting from and landing on the water is only permitted in one of the tests A and B.

4. The course on which the aviator accomplishes tests A and B must be marked out by two posts or buoys situated not more than 500 meters (547 yards) apart.

5. The turns round the posts or buoys must be made alternately to the right and to the left so that the flight will consist of an uninterrupted series of figures of 8.

6. The distance flown shall be reckoned as if in a straight line between the two posts or buoys.

7. The landing after the two distance flights in tests A and B shall be made:

(*a*) By stopping the motor at or before the moment of touching the ground or water;

(*b*) By bringing the aircraft to rest not more than 50 meters (164 feet) from a point indicated previously by the candidate.

8. All landings must be made in a normal

manner, and the observers must report any irregularities.

Hydroaeroplane Pilot's Certificate

The tests to be successfully accomplished by candidates for this certificate are the same as those for an aviator's certificate, except that starting from and landing on the water is permitted for all of the tests.

Instructors in the French aviation schools pay special attention to volplaning from great altitudes and to turning or banking. Even after a student has learned to execute complicated manœuvers high in air, he must fly for several weeks before allowed to try for his brevet as a military pilot.

Final examinations are most exacting. The applicant must rise twice to an altitude of six thousand feet, and spend an hour at a ten-thousand-foot altitude. After passing this test he must fly over a triangular course of one hundred and fifty miles, landing at each corner of the triangle. The final test consists of ascending to a height of one thousand five hundred feet, cutting off all power, and descending in a spiral to a fixed point.

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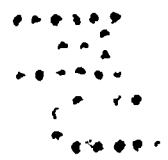
Students in a modern aviation school well may dread their "exams," nor would it be considered much of a disgrace to "flunk" them.

Examinations for pilot licenses in the army and navy of the United States are no less "stiff." An elaborate course of advanced training for American air men has been planned, which will be carried out in the near future. The army air men will be drilled in "spotting" artillery fire, wireless signaling, cross-country flying, scouting and air dueling. In the navy, this advanced work will include bomb-dropping, aëro gunnery, "spotting" the fall of shots, launching planes from ships, and ocean flying.

The training received at the Signal Corps Aviation School at North Island, San Diego Harbor, affords an excellent illustration of our progress in this field. The island, comprising twelve thousand acres, is considered by experts the finest base in the world—both for land and water flying. Here, at the present writing, are upwards of two hundred and fifty enlisted men with more than fifty officers. During the first half of 1914, four

thousand flights were made at this school, with a total time aloft of one thousand eight hundred hours. The air mileage was equivalent to more than four times the circumference of the globe. This remarkable record was achieved without a single serious accident.

Before venturing within range of battery fire, the army air man must make himself familiar with the theory of trajectories of all types of guns. Even when flying at high altitudes, he is in constant danger of being brought down by a chance shot from friend or foe. Modern artillery fire is extremely complicated, and the pilot must have its mathematics at his finger tips, if he hopes to dodge it. He must be able to judge accurately the parabolas of shells from every variety of cannon and of every bore. A very heavy shell, for instance, travels in a great arc until almost directly above its target, when it falls almost vertically. Extreme long-range guns, on the other hand, travel in a high parabola. An entirely different problem has to be worked out while dodging shrapnel or anti-aircraft guns. A skilful



airman, after studying the position of batteries beneath him and the nature of their fire, can actually thread his way with comparative safety amid a rain of shells.

A surprisingly small proportion of accidents to air men are fatal. It is only falls from great altitudes that the public hears about. The commonest form of accident among air men are injuries to the feet. A miscalculation in landing or an unexpected air-current may pitch the aviator out, but the fall is likely to be for only a few feet. He always is ready to jump, and usually a sprained or broken ankle is his worst injury. Incidentally, the engine is usually placed as far forward as possible in order to prevent air men from being crushed in just such accidents. Since an air man depends less upon his feet than his hands, these accidents do not often incapacitate him.

Many air men suffer from injuries to the neck, caused, for the most part, by collision with the ground. To guard against this as much as possible, the air man, nowadays, is usually fastened to his seat by an abdominal belt. This keeps him from slipping forward

at an unexpected impact. Some serious accidents have been caused by an air man's head being thrown violently forward on collision with the ground and striking against the superstructure of the aëroplane. Since an aëroplane travels much faster than any other vehicle, the percentage of accidents of all sorts is naturally high. The eyes are rarely injured, except by exposure to extreme cold. Frost-bites are comparatively common. The gas used in the engine often produces headaches and nausea. Many air men especially dread to sneeze at a critical moment. A number of bad accidents have been attributed to a sudden sneezing fit which caused the air man momentarily to lose control of his machine.

For more difficult feats of airmanship which qualify the brilliant fighting pilots, the aviator must be born, not made. To withstand the strain of long flights and, especially, of air battles, a man must enjoy more than average good health. He must cheerfully face constant danger. The man who fears to face death, grows nervous while anticipating dangers to come, sleeps badly and

so finds himself in a nervous condition, had better give up flying at once. It is not enough that he should be brave, even enthusiastic in his work. Come what may, the air man must possess absolutely untroubled nerves.

The physical, as well as moral, strain in such flying is far greater than commonly supposed. The fatigue of guiding an aëroplane hour after hour, with every sense on the alert, soon tells on the strongest constitution. In extremes of heat or cold, often without food, the air man must prove as dependable as his machine. Some interesting scientific observations on conditions aloft have been collected which throw an interesting light on the problem. It is not generally realized, for instance, that air-sickness attacks the landlubber in the air, just as it does at sea. Like the sailor, the air man must accustom himself to the rolling and pitching of his craft. Obviously it is more dangerous for an air man to have an attack of dizziness or nausea than for a sailor, since everything depends upon the latter's steadiness of eye and hand.

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An air man must fight against the constant alteration of blood pressure. Many people feel the effect of varying pressures while traveling quickly by elevator from the bottom to the top of a high building or the reverse. The ears ring and often there is an unpleasant feeling of deafness or dizziness. How much more serious must be the effects while rising or descending thousands of feet in a few seconds. This physical effect is often experienced when flying on the same plane and varying the speed of your aircraft. As pressure decreases on attaining higher altitudes, a variety of ill effects follow in regular sequence. After passing an altitude of about a mile, the first feeling is a ringing in the ears, next comes breathing troubles, and lastly, a rapid increase of the pulse. Should the aëroplane cease to rise and continue flying on the same plane, these symptoms will diminish. On the other hand, they may be increased by encountering air currents.

After climbing to still higher altitudes, the pressure on the heart may become very dangerous while breathing grows extremely la-

(c) *Brown & Dawson*

Looking down on the German Aviation School at Lubeck

(c) *Brown & Dawson*

Group of pupils in the Lubeck Training School

bored. A violent headache may develop in a few seconds. The air man often suffers acutely from this ailment. Sometimes his arteries throb and there is a violent beating in his temples, while the variations in blood pressure easily fatigue his heart. The brain is frequently so affected that aviators have been known to go sound asleep in their machines. Some of the so-called "mysterious" accidents may be explained in this way.

In trying for altitude records, some air men carry with them a special supply of oxygen to breathe in these rarified regions. The blood may undergo chemical changes at high altitudes which will seriously affect both brain and digestive organs, leading to permanent injuries. It is easy to understand why the age limit is much lower for aviators than in any other branch of army or navy service.. Only the sturdiest bodies can stand the strain of long flights.

As the demands made upon pilots have become more exacting with the progress of the war, the standard of fitness had risen correspondingly. In examining recruits for any other service of the army the exami-

nation usually consists merely in estimating the applicant's lung capacity, chest measurement, condition of teeth, eyesight, weight, and general condition of health, but the prospective air pilot must stand far more rigid and searching tests.

The method employed for testing the nerves of would-be air pilots for the French army is doubtless the most complete and scientific. A number of highly ingenious scientific instruments have been especially devised for the purpose. The first care of the examiner in their system is to ascertain what is called the "personal equation" of the candidates—or, the time that it takes him to give expression to the impressions he receives. For this purpose a chronoscope is used, which consists of a clock-face divided into a hundred parts, with a pointer which makes one complete revolution of the dial in one second. The indicator when set in motion may be arrested by squeezing together two strips of metal held in the right hand of the men being examined. The doctor taps with the hammer on a tin box, and sets the hand spinning round the clock-face.

The instant the sound of the tap reaches the ears of the examinee, he squeezes the strips of metal together, and stops the revolution of the pointer. The distance that the pointer has traveled before he stops it shows the number of hundredths of a second that it has taken him to record his impression. The applicant's impressions of sight are tested by stopping the motion of the pointer on signal. A successful candidate will stop the pointer in fifteen-hundredths of a second after receiving impression of touch or hearing, and nineteen-hundredths of a second in the case of impressions of sight. If his figures run up to from seventeen to thirty-three hundredths for hearing, twenty to thirty-nine hundredths for touch, and twenty-two to forty-eight hundredths for sight, he is unfit to attempt the dangers of flying.

The strength of the candidate's nerves are also thoroughly tested with an instrument known as the pneumograph, which records the rate of his respirations. The first two fingers of his left hand are inclosed in a little apparatus which shows the action of his heart or pulse; while he holds in his right

hand the "trembler," which registers the steadiness of his hand in much the same way as the seismograph records the tremors of the earth. All three are connected with pointers, each of which traces a line on a revolving drum covered with lampblack. The shock to the nerves is given either by the firing of a revolver close to the examinee, by the magnesium flare used by photographers, or by the unexpected placing of a cloth dipped in iced water on the examinee's bare skin. By these means three separate lines or "curves" are simultaneously traced on the revolving drum.

So much depends upon the pilots resisting the fatigue of the nerves and muscles of the hands and arms that tests are made by a special instrument. The would-be pilot places his right hand palm upwards on the apparatus, inserts a finger in a kind of finger-stall so contrived that the bending of the finger raises a small weight, while the "curve" produced by the repeated bending of the same finger before the consequent fatigue of the muscles makes this contraction painful or impossible is recorded on a disc.

Studying a model aëroplane at the Mineola Aviation School

The importance of a high degree of endurance in this respect may be judged when one considers the number of times the controlling levers of an aëroplane have to be pulled and the firmness of the grip that the airman has to keep upon them.

CHAPTER II

NAVIGATING THE AIR

ALTHOUGH navigation of the air and sea are much alike, the sky-pilot faces far more complicated problems. While guiding his craft, an air man always must reckon with a third or vertical dimension, a trifling miscalculation at any moment often causing a fatal plunge. In addition, the air man must be a good sailor to guide his craft through baffling winds. The directing of the highly developed aëroplane engine also demands great technical skill. The bridge or dash-board of the aëroplane, as it is called, is equipped with many complicated instruments which must be watched with invariable attention. The air pilot's equipment may include, among other things, an altimeter, an inclinometer, an air-speed meter, a drift meter, an angle of attack meter, a stabilized

telescope, a distance indicator, spirit levels, a sextant and a compass. To manipulate this complicated keyboard, the air man would seem to need a dozen eyes and as many hands.

Few air men go aloft without a barometer or altimeter. From long experience a pilot learns to judge his altitude with remarkable accuracy. When he rises above a mile, however, the earth slowly fades into an indefinite gray-green plane in which it is wellnigh impossible to recognize landmarks. In flying still higher or above the clouds, the air man is completely at sea, so to speak, and, without an altimeter, cannot be sure whether he is rising or descending. Conditions often must be faced where it is of vital importance to know one's height within a few feet. In altitude contests the barometer is often locked before rising and, upon descent, is only opened by judges of the contest. The automatic record it preserves decides which aëroplane has risen highest and so wins the contest.

The air-speed meter serves several important purposes. It is vital to the air man's

safety that this instrument indicate the aëroplane's slowest as well as fastest pace. When a machine, for instance, is banking strongly on a turn, the mechanism must be free from effects of acceleration. An excessive speed in gliding is very dangerous and the meter should warn the pilot against bringing up his machine too sharply. Again, when flying at high speed,—that is, in excess of a hundred miles an hour,—the angle of attack is so small that, without some such caution, the machine may enter a critical condition before the air man realizes his danger. It is also of utmost importance that a pilot be able to read his lower speeds accurately, especially the "stalling speed" or lowest speed limit for safe flying. If the aëroplane slows down below a certain speed, its wings will cease to support it and a plunge is imminent. The air-speed meter warns the air man of this danger and so gains for him a few seconds of priceless time.

There are two types of drift meters in common use to-day. One indicates the leeway the aëroplane makes, the second the sideslip, showing, at a glance, whether the

machine is flying square to the wind. The experienced air pilot can tell the drift of his machine by observing the apparent motion of fixed objects on the ground beneath him, but the drift meter gives him accurate observation. It consists of a telescope mounted vertically so that a pilot may look down upon the ground directly beneath him. This telescope contains a series of parallel wires with a graduated scale and pointer. A sailor can judge the drift of his boat by comparing its course with the lines of the waves. Just so, by turning the telescope of the drift meter so that the cross wires are parallel with the lines of motion,—that is, the roads or shore lines below,—the exact drift is measured by the needle of the indicator. Any landlubber knows, of course, that air currents aloft change so rapidly that charts and tables are out of the question. The drift indicator, therefore, is invaluable.

The simplest form of sideslip meter is a weighted string or plummet, but this cannot be used in the wake of propellers whose air currents throw them out of plumb. Another type of instrument consists of a very delicate

pendulum that indicates the lateral acceleration.

Safety in flight is so dependent on the angle of attack that a special instrument known as the angle-of-attack meter has been devised to give an accurate reading. By angle of attack is meant the inclination of the planes in rising or falling, measured with the horizontal. If the air pilot rises at too steep an angle, he loses his balance and a fatal fall may result. The meter shows the changes in the direction of the flow of air to the surface of the planes. It is free from gravitation and extremely sensitive to air currents. This meter it attached to the frame in advance of the wings on a tractor aëroplane, while if the machine be driven by propellers, it must be kept free from air currents stirred up by them.

An indispensable instrument on the bridge of an aëroplane is the spirit-level. The experienced air man learns to judge with remarkable accuracy how far his craft swings from an even keel. At great altitudes, however, when there are no fixed objects in sight for comparison, balance is often very decep-

tive. While sailing above the clouds or in a fog, for instance, and especially in making steep banks or spirals, all sense of equilibrium may be lost. As one air man has put it: "There are times when you cannot tell whether you are on your head or heels!" The spirit-level or inclinometer is designed especially for aëroplane use. It must show at a glance whether the aëroplane is pitching or rolling to port or starboard, also its exact degree away from the horizontal position. One of these devices is U shaped and is set on the bridge at an angle of about 45 degrees so that it can indicate every motion of the craft.

In flying over the sea or unfamiliar country, a distance indicator is extremely valuable to an air man. It is impossible to calculate the distance flown from the speed of your propellers, since their driving power varies when they are climbing or diving. The record made by an anometer must be corrected again by the wind velocity and its direction.

No one has as yet succeeded in constructing a satisfactory aëroplane director, though

the general principle on which it should work is well understood. It must indicate mechanically the course and distance to be followed, based on the speed of the aëroplane and the force and direction of the wind. The sextant used at present in long flights is far from satisfactory. Some instrument must be devised that will take the altitude of heavenly bodies above a horizontal plane, without making use of the sea horizon.

The rapid motion of an aëroplane in flight makes it very difficult to train a telescope on any object below or above the pilot's line of vision. A sailor with good sea legs can balance himself against the rolling and pitching of a ship and keep his glass fairly steady, but the air man, being seated, swings with the motion of his craft. A special aëroplane telescope has been devised with a stabilizing device that holds it permanently at any desired angle to the horizontal. To study the ground directly beneath or pick up another craft higher up, the stabilized telescope may, at a touch, be brought to position and will remain "put" independent of the aëroplane's motion.

Instruments for navigating the air

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The compass is almost as essential to an air man as it is to the mariner at sea. In long flights, especially at high altitudes, the pilot may be out of sight of earth for hours, or the country may be so unfamiliar to him that he finds himself hopelessly lost. He must, so to speak, fly by dead reckoning. The compass used on aëroplanes has as high a directive force as is possible in relation to its size. The needle must come to rest and point steadily, no matter how the air craft swerves from side to side. A ship at sea swings slowly about while an aëroplane is very readily sent off its course. The air-ship's compass is placed as far as possible from the machinery, such as columns, shafts and leads. In mounting it, special care is taken to guard against the influence of any magnetic material. When reading the compass, the navigator of the air must make due allowance for heeling and dipping errors. These instruments are usually of the "marching compass" type used in the army and work equally well at any angle. The dials are ordinarily marked with lines and figures that are radio active, and therefore luminous and

clearly visible while making night flights. In addition, the aëroplane pilot often uses a walking compass strapped just above the knee which is far more convenient for him than a wrist-watch would be.

Several of the instruments on the bridge are operated electrically while the binnacle lamp and colored signals to port and starboard of the planes also require electric power. An ingenious motor has been devised to generate sufficient current for this purpose. It is installed on one of the planes, taking up very little room, where the force of resistance to the air is converted into an ample supply of electricity. The dynamo is usually placed in line with the propellers, so that the current of air stirred up supplies electric power to light the lamp and animate the navigating machinery even before the aëroplane leaves the ground.

One of the latest devices installed on the "bridge" of airships consists of three small signal lamps,—white, green and red,—which warn the pilot of approaching danger. When this signal is connected with the stallometer, for instance, the white lamp

burns continuously as long as the aëroplane travels at normal speed. Let the craft slow down below a certain pace,—say a mile a minute,—and the green light instantly flashes. The red signal shows only when the craft approaches the "stalling" limit and the aëroplane is actually in danger of falling. The same device can be connected with the incidence indicator to warn the pilot of approaching danger.

Still another electrical signal connects the pilot's and passenger's seats. The roar of the propellers drowns the voice and, since the two seats may be several feet apart, it is difficult for a pilot to make himself heard. An elaborate device is sometimes installed to enable the pilot to instruct a pupil by signals. By pressing a button beside the pilot's seat a tiny electric sign is made to flash in front of the pupil. It is possible to give a dozen different directions, such as, right, left, up, down, faster, slower, dip, etc. The instructor can thus direct a pupil without the loss of a fraction of a second, for in guiding an aëroplane time is very valuable. The same contrivance reversed enables a passenger to

direct his pilot by such orders as, descend, elevate, faster, slower, or "home."

The air pilot must also keep a watchful eye upon a variety of gages and indicators connected with the mechanism of his craft. There is an oil gage that shows the pressure of oil in the crank case and an oil pressure gage indicating the flow of oil. The gasoline gage shows at a glance the amount of gas available in the main tanks. There is a pressure indicator to show how this gasoline is fed. This has been especially designed for aëroplane use, since the gasoline is not fed by gravity and is affected by change of temperature. The radiator temperature indicator must be especially rigged to withstand the violent vibrations and shocks of an aëroplane flight. There is also a self-starter within easy reach of the pilot's seat. An aëroplane carries electric lights to port and starboard like any ship. These are switched on and off from the pilot's seat. For night flights a powerful searchlight is also of great value to illuminate landing places or pick out other air craft aloft. Aboard the great pas-

senger aëroplanes of the future, the crews will probably comprise a steersman, an engineer and a navigation officer with, perhaps, several assistants. To-day a single pilot must struggle with all these problems.

The arrangement of lights for night flying has been worked out with great care. Aboard battle planes it is, of course, imperative that all lights be concealed. An aëroplane may be betrayed by the flash of its exhaust, but there is nothing else to serye as a target for an enemy. The specifications of the British Government, for example, provide two lights on the instrument board, carefully shielded from the pilot's eyes. Another light is placed at the bottom of the fuisélage, or car of the aëroplane in case of need. This may be of service in adjusting the machinery or to operate bomb-dropping devices. A special light shines on the compass and one portable torch is carried by each machine. If an aëroplane is not equipped with a special motor for supplying current, dry batteries are carried that may be thrown overboard when exhausted.

Enough current is carried along to run the lights for eight hours,—the maximum length of flights on these night patrols.

An air man must be skilful and alert in reading maps. The ordinary traveler who loses his way can stop to make inquiries. An aëroplane may pass through clouds or mist that conceal every landmark. From high altitudes the most familiar landscape may be difficult to recognize. The pilot must learn to judge the height of hills and size of towns at a glance and must be able to calculate the direction of a straight line between two points, translating this direction into degrees on his compass.

The congestion of the air routes in some parts of Europe have made it necessary to establish definite rules for regulating the air traffic. The regulations announced by the Royal Flying Corps are especially rigid, as illustrated by the following quotation:

Aircraft Meeting Each Other.—Two aircraft meeting each other end on, and thereby running the risk of a collision, must always steer to the right. They must, in addition to this, pass at a distance of at least 100 yards.

Aircraft Overtaking Each Other.—Any aircraft overtaking another aircraft is responsible for keeping clear and must not approach within 100 yards on the right or 350 yards on the left of the overtaken aircraft, and must not pass directly underneath or over, save when the vertical distance is in excess of 800 feet. No aircraft shall remain persistently below or above another. In no case must the overtaking aircraft turn in across the bows of the other aircraft after passing it or move so as to foul it in any way.

Aircraft Approaching Each Other in a Cross Direction.—When any aircraft are approaching one another in cross directions, then the aircraft that sees another aircraft on its right-hand forward quadrant—from 0 degrees (i.e., straight ahead) to 90 degrees on the right-hand constitutes the right-hand forward quadrant—must give way, and the other aircraft must keep on its course at the same level till both are well clear.

Distance to be Maintained from Airships.—When one of the aircraft is an airship, the distance of 100 yards prescribed above shall be increased to 600 yards.

Long Glides and Quick Rises.—Except when prearranged for instructional purposes or in cases of emergency, long glides and quick rises will be practised only to and from the usual landing area.

Position of Other Aircraft to be Noted Before Starting.—Aëroplane pilots will, when starting, carefully note the position of other aircraft and will be responsible for keeping clear of them.

Danger Flag to be Hoisted Before Aëroplane Flying Commences.—No aëroplane flying will take place without a red flag being hoisted at the appointed place as a warning to all concerned. In cases where the flag is likely to be mistaken for other danger flags, the flag of the Royal Flying Corps will be hoisted immediately below the red flag.

Landing Marks.—Permanent marks will be made on the ground at the usual landing place to indicate the nearest points at which it is safe for aëroplanes to land in directions facing the sheds, etc. An aëroplane landing in such a direction must be on the ground before it reaches the point in question.

Flying over Towns.—Flying unneces-

A flying boat just rising from the water

sarily over towns and villages is to be avoided.

Dogs.—No dog not on a leash is allowed in the starting and landing area while flying is in progress.

It has been necessary abroad to build a special form of lighthouse for the guidance of air men. A sailor at sea will observe any light placed on a level with or above his range of vision. The aërial lighthouse, however, must send its rays so that they will be clearly visible from any point above the lowest flying level. Again, its light must be thrown uniformly in all directions so that it will appear the same whether sighted from a point directly above or on a level with it.

A most effective aërial signal-light consists of a belt of several lenses with a lamp placed at their focus so that the rays shine uniformly in all directions. As in sea-coast beacons, these lights must each give a distinctive signal, so that the air man sighting them miles distant may definitely fix his position. The best plan discovered thus far is to flash the light on and off in a series of dots and dashes in the Morse code. Colored

lights are also used, but these are harder to distinguish. An air man sighting one of these beacons can pick up the signal in a few seconds and, by consulting his code books, quickly identify the light and lay his course accordingly.

Some of the aërial lighthouses in Germany have fifty-thousand-candle-power lamps that are clearly visible twenty-five miles away. These powerful lamps are often mounted on lighthouses raised fifty feet or more above the ground or whatever the lowest flying level in their vicinity may be. When one of these beacons is placed on some mountain or other high elevation, it must be especially designed to throw its rays downward so as to be visible from beneath. These great lights help the air man to steer a straight course and prevent him from being lost and wandering across frontiers or over the sea-coast. In years to come terra firma, viewed from aloft, will be twinkling with these signals.

The dream of the air man is absolute automatic control of the aëroplane under all air conditions. Earlier types of the aëroplane were at the mercy of every wind-gust. The

slightest change of balance, even a trifling error, might bring instant disaster. So rapid has been progress in aircraft navigation that a well-equipped aëroplane to-day may be depended upon to sail a fixed course without guidance under ordinary conditions. Let such a craft be knocked off its course, even almost capsized, and it will right itself unaided. Many pilots have told of the marvelous stability of machines after they had lost control. With the machine apparently dashing down at frightful speed to certain destruction, the pilot has let go of the steering apparatus and leaned back in his seat, waiting for the end. Then the aëroplane, as if by magic, has come to an even keel and continued on its course. As aëroplanes grow larger and more complicated, it becomes increasingly difficult for one pilot, no matter how alert, to operate engines and steering mechanism at the same time. The use of stabilizing devices renders the aëroplane practically automatic, leaving the pilot's hands free to make observations, consult his maps and charts, or, in the case of war craft, to work his gun.

THE AIR MAN

Several ingenious devices have recently been invented by Wright, Sperry, Clark and others that render an aëroplane almost as safe as an automobile. The rudders that control the position of the aëroplane are automatically governed by a pendulum. As the aëroplane rolls or pitches away from an even keel, an electrical apparatus turns the controlling rudder just far enough to counteract this motion. The gyroscope is used to keep the aëroplane level, no matter how air currents may tend to knock it off its course. With one of these stabilizing devices at work, the pilot has practically nothing to do but steer his craft. Here is the log of a recent air-cruise to New York that gives a very vivid impression of sitting in the pilot's seat. Mr. Lawrence B. Sperry, the inventor, who guided the aëroplane, before starting set his automatic pilot at 2 degrees longitudinal inclination and the device guided his aëroplane throughout the trip.

Time	Place	Altitude	True Heading	Inclination Gyro Unit
12.02	Amityville		south of west 250°	2°
12.08	.....	300 ft.	" " " 255°	2°
12.13	.....	400 "	" " " 240°	2°
12.15	Freeport	500 "	" " " 240°	2°
12.18	.....	500 "	" " " 230°	2°

NAVIGATING THE AIR

Time	Place	Altitude	True Heading				Inclination Gyro Unit
12.21	Long Branch	500 ft.	south	of	west	250°	2°
12.23	.....	500 "	"	"	"	260°	2°
12.27	Cedarhurst	700 "	due west				2°
12.30	Rockaway	900 "	south	of	west	260°	2°
12.37	Rockaway Pt.	1150 "	"	"	"	260°	2°
12.39	.....	1200 "	"	"	"	260°	0°
12.40	Sheepshead Bay	1200 "	north	of	west	300°	0°
12.42	Coney Island	1200 "	"	"	"	320°	0°
12.45	Sea Gate	1300 "	"	"	"	315°	0°
12.48	.....	1400 "	"	"	"	330°	0°
12.49	Fort Hamilton	1500 "	west	of	north	345°	0°
12.55	Governor's Island ...	2000 "	"	"	"	350°	0°
1.03	129th St. and Hudson River	2200 "					

Remarks: Light wind; 10 miles per hour. Engine speed; 1325 revolutions per minute.

CHAPTER III

THE AERO-SPORTSMAN

THE delights of cruising on the magic carpet of the Arabian Nights may be enjoyed to-day by all. The speedy racing and pleasure aircraft lend new excitement to a variety of sports. The racing aëroplane which travels one hundred and forty miles an hour or better makes every means of transportation seem commonplace by comparison. The hunter finds it a unique experience to pursue his game on the wing. The air yachtsman looks down upon all surface boating with good-natured indulgence. For hosts of amateur photographers, picture-making in the air holds a new delight.

At present, the most popular type of aircraft for pleasure cruising is the so-called airboat. When the hydro-aëroplane first appeared, sportsmen at once recognized the attractions of this new vehicle. Here, at

last, was a craft that could navigate both air and water. At the touch of a wheel, one could skim over the water at fascinating speed or mount to high altitudes and leave the world behind.

The first hydro-aëroplane, however, was more of an air craft than a boat. At best, only two passengers could be accommodated. When afloat, it rested on substantial pontoons and was only fit to rise from quiet waters. This type of craft has been quickly developed and the latest models are marvels of speed and even luxury. It is no longer only a fair weather craft. In either rough water or high winds it proves itself airworthy or seaworthy as the need may be.

A party of sixteen has been carried aloft in one of the air-craft which may, without exaggeration, be called an air yacht. In the majority of models the car or boat contains comfortable seats for five. They are arranged much the same as in the conventional touring car, two behind the others, with a convenient door between, so that passengers may change their seats even when sailing aloft. The cockpit is usually finished in

some hard wood, preferably mahogany, and the seats are heavily upholstered in pigskin. The deck is carried out in the same wood and the hull painted white with a green water-line. A cabin top is placed over the cockpit in rough weather to keep out the spray from a rough sea or the cold air currents of the upper altitudes. The mechanic sits at the rear, just below the upper plane, though the craft is steered from the front seat of the cabin.

The largest of these air yachts will fly with a full load at a speed of seventy-five miles an hour, and have a cruising radius of about five hundred miles. A rather extended cruise both by air and water is thus possible without stopping to replenish fuel. The lines of an air yacht are graceful and suggest a high-speed boat equipped with wings. The largest type have a wingspread of seventy-six feet, while the boat measures fifty-four feet from prow to stern. It draws eighteen inches of water when loaded, and will leave the surface after a run of thirty seconds.

In this type of aircraft may be seen the

Looking down on a crossroads "somewhere in France"

general form of the great passenger-carrying airships of the future. When the air-yachts are built larger, cabin accommodations will quickly improve. Had it not been for the European War, which directed the genius and enterprise of aviators toward the building of battle craft, the air yacht would doubtless already have had an amazing development. It seems safe to assume that the craft that makes the first transatlantic flight will be constructed on these general lines.

The largest passenger-carrying aëroplane in existence is one built and flown in Russia. A party of twenty one has been carried aloft in this giant craft for a six-hour flight. It is equipped with a really luxurious cabin which contains several surprising features. On one of its flights, a number of members of an aëro-club were carried aloft to a considerable altitude. During the flight the passengers, comfortably seated about a central table in the cabin, held a formal club meeting. A meal was actually cooked in the air on an electric stove and afterwards served at table. The seats are also convertible into beds so that something ap-

proaching steamship accommodations can be enjoyed while cruising at high altitudes.

The demand for airboats in America attests the popularity of the new sport. A single firm in the United States had orders for twenty-five large airboats to be delivered in the spring of 1917. The cheapest of these cost $8500 while the more sumptuously fitted craft sold for $10,000. The sport, by the way, is likely to be expensive. A pilot familiar with the complicated engines used in these craft commands a salary of around $40 a week, and the machinery must be fed only high-grade gasolene.

While European manufacturers have been turning out war craft, it has remained for America to build the first luxurious aërial limousine. The car of this airship, designed like a modern sedan, contains three richly upholstered seats, having low windows at the sides, front, and rear to command a view of the earth beneath. It is a triplane driven by an eight-cylinder, one hundred horsepower motor. This craft remains upon the ground until a speed of forty-five miles an hour is attained, when it soars aloft

and is capable of doing sixty-five miles an hour. The purchaser may choose the color and design of the upholstering. The aërial limousine sells for $10,000. It will be remembered that the first bicycles and automobiles commanded high prices but in a few years competition brought them within the reach of people of moderate means.

The general use of aircraft is expected to have an important influence on real estate values. The owner of a flying boat or seaplane will naturally select a country home on the water front, and demand a convenient inlet or cove for landing his aircraft. Several owners of real estate on Long Island Sound even now point out the attraction of their property from the aëro-sportsmen's point of view. As this delightful means of travel becomes more common, the aëroplane commuter will appear. The commuting radius will be greatly extended. A country home upwards of a hundred miles from a business section will be brought within less than one hour's flight, and the value of outlying districts will be greatly increased in value.

THE AIR MAN

It has been pointed out by a prominent landscape gardener that the aëroplane will doubtless have an important influence upon the form of country estates in the near future. In the old days of horse drawn carriages a house was naturally placed near the public roads, the driveway was shortened, and the gardens were placed at the side or in the rear. The automobile made it possible to place the house further back from the public thoroughfare, thus gaining additional privacy. The estates of the future may require convenient landing places with hangars for air craft equal in size to a dozen tennis courts, which may be placed entirely independent of the roads. The general architectural schemes of the estates of the future will also be influenced indirectly by the advent of air craft.

The aëro-sportsman will find hunting in the sky the most thrilling sport in the world. Instead of lying in ambush for winged game, the airman pursues his prey aloft, at a superior speed. His airmanship is matched against the flight of the wariest game. While pursuing the fleetest animals in the

One hundred miles an hour

open, the air-sportsman again can sight his game at a distance and pursue it without encountering obstacles. The wilder the game, the more cleverly it struggles to elude pursuit, the better is the sport.

A speed of over one hundred miles an hour gives an enormous advantage to the sportsman of the air. A duck or eagle, even when flying with the wind, can scarcely do half as well, while a rabbit or deer is, of course, hopelessly outclassed. Once sighted by an air-huntsman, the latter's chance of escape lies in doubling on their tracks, or in darting from side to side more quickly than the air pilot can manœuver his craft. In a straight flight, the hunter is likely to overrun his quarry, leaving it so far behind that it may escape.

The aëroplane is so unfamiliar to all forms of wild game aground and aloft that it fails to frighten them. A hunter with a gun or pack of dogs will be quickly scented but the smell of gasolene fails to arouse fear. It is common for birds to regard the strange visitor with curiosity, and actually circle about or pursue it without the slightest

timidity. Many kinds of wild game which would seek to escape at the first sight of an ordinary hunter, have not yet learned to look aloft for possible danger. The air man, gun in hand, can stand in the cockpit of his aëroplane and choose his own range. No air man as yet has hunted big game from an aëroplane, but doubtless the wildest and fleetest game, such as elephants or lions, will be brought quickly to bay by a skilful air man.

The first aëro-hunting in America was enjoyed by Hubert Latham, the French air man, while visiting the Bolsa Chico Club at Los Angeles. Latham flew low over a feeding ground and, when the birds broke cover, brought down, or rather sent down, a large number of them. A hunting party of this kind consists of at least two persons, the pilot and a marksman. The superior speed of the aëroplane over the fleetest birds was recently illustrated when an air man overtook an eagle at such a pace that one of the wire braces struck and killed the bird, cutting it nearly in two. It calls for a cool hand and steady eye to hit a mark while traveling at

a speed of perhaps two miles a minute. The champion wing-shot of the future must establish new standards of skill and daring.

One very exciting form of sport is to chase wild rabbits or coyotes over open country with an aëroplane. In searching for game, the air-huntsmen enjoy a great advantage, since they can sail quickly over hills and valleys, easily covering a mile a minute, while escaping all the drudgery of the chase. A party of three air men recently enjoyed a typical experience of this kind in the San Fernando Valley in California. Arrived at the hunting ground, the aëroplane scouted about at a leisurely mile-a-minute pace, while one of the party searched the ground directly beneath with a strong glass. The first game sighted was two coyotes chasing a cover of quail. All were entirely unconscious of the danger threatened from above. To avoid frightening the game by the whir of the propellers, the engines were shut off and the aëroplane volplaned down until the hunter was scarcely three hundred feet above the ground. The first shot killed one of the coyotes. The

second coyote was so bewildered by this unexpected attack that it made no attempt to escape and was brought down by the next shot.

The air-huntsman has been unusually successful while hunting from the hydro-aëroplane. When flying close to the surface of the water it is easy to distinguish large fish, even at a considerable depth. A most amazing hunt of this kind occurred off Atlantic City in the summer of 1916 during the shark scare. Mr. Neryl H. Kendrick shot more than thirty sharks from his hydro-aëroplane. By skimming swiftly and silently over the sea, he surprised the sharks and brought himself within easy rifle range before they realized their danger. Meanwhile the motor boats sent out to catch them, usually scared them away. Ducks and seagulls have been hunted by aëroplane with great success along the Atlantic coast. It has even been possible to retrieve birds by flying very low and scooping them up with a hand net.

The aëroplane is the ideal racing craft. No other vehicle can hope to rival its speed

Photo by International Film Service

Bringing in a shark shot from mid-air

or distance qualities. Aërial contests are decided aloft where they can be enjoyed by vast audiences, distributed over great stretches of open country—a fact that makes this sport the most democratic in the world. From the earliest days of aviation, American air men have looked forward to a real race between Chicago and New York—one which would outclass the speed of the fastest express trains.

The first attempt at this was made as far back as 1910 when a purse of $25,000 was offered by Chicago and New York newspapers. Eugene B. Ely, who started first, had flown but thirty miles when the flight was abandoned. Several other such flights were planned but it was not until November 2, 1916, that Victor Carlstrom finally started on his daring attempt. He rose at 6:09 A. M. and, after soaring to an elevation of two thousand feet, flew eastward. He had already broken the American non-stop flight record, when a slight engine trouble caused him to land at Erie, Pa. Repairs were quickly made and he rose again at 2:35 P. M. Flying at amazing speed, he landed at Ham-

mondsport, N. Y., at 4:24 P. M. and spent the night there. At 6:35 next morning he was again in the air, and flew to Governors Island, N. Y., without alighting, thus establishing a new American speed record for cross-country flight. The distance of 315 miles was covered at the rate of 134 miles an hour, or faster than two miles a minute, while the total distance of 967 miles from Chicago to New York was flown in 8 hours, 28 minutes and 30 seconds.

A few days later, on November 21, much the same course was covered by Miss Ruth Law. This flight, in some respects, bettered the previous remarkable record. The machine used in this second flight was scarcely half the size of Carlstrom's, and the plucky little pilot sat in an extremely exposed position. Her fuel running low at one point, she was obliged to stop her engines in mid-air and dip her machine at a precarious angle to make the gasolene flow into the tank. Her first stop out from Chicago was at Hornell, N. Y., 590 miles distant. This bettered Carlstrom's best cross-country non-stop record by 138 miles. Miss Law's flight

of 884 miles was covered in 8 hours, 55 minutes and 35 seconds. Both flights prove, if proof be necessary, that American aëroplanes and pilots compare favorably with any in the world.

The great classic air race of the future promises to be an American Aërial Derby. The course will span the continent, and the race, starting at the Atlantic coast, will only be decided upon reaching the Pacific Ocean. No contest in history has ever been planned on such ambitious lines, and certainly none will have been enjoyed by so great an audience. Scores of cities along the route will serve as control stations. Here the competing air men will alight for supplies, so that tens of millions of spectators may witness the contest. It is expected that fifty aëroplanes will enter this contest and the prizes will total $100,000. Work has long been in progress in mapping the route and surveying and correcting the air course.

The Aërial Derby will be, in a very real sense, a national event. It will open the first trans-continental aërial highway. Since America was the first nation to give

the aëroplane to the world, it is peculiarly fitting that the greatest test of speed and endurance should be flown above American soil. Interest in aëronautics will be re-awakened. No other contest in the air will probably do so much to demonstrate the practical usefulness of the aëroplane for carrying passengers and mail. Generations to come, while perhaps smiling indulgently at the two-miles-a-minute pace at which the aëroplanes first crawled across the continent, will admire the wisdom and energy of the men who first conceived and realized so ambitious an undertaking.

But for the European war, the Atlantic Ocean would doubtless have been crossed before this by aëroplanes in a single day. A small fraction of the energy and wealth which has been expended in building war planes and training men to fight them, would have sufficed to solve the transatlantic problem. As early as 1912 the contest committee of the Aëro Club of America was asked to arrange the conditions for such a flight. In the following year a prize of $50,000 was offered by Lord Northcliff for the first aërial

crossing of the Atlantic. Before the war the scheme had been so far realized that a special aëroplane, christened the "America," had been built to make the flight, and the plans worked out by experts in great detail. The aëroplane was acquired, however, by the British Admiralty for war purposes and the Atlantic flight postponed. The showing made by the "America" in war service has been carefully watched, however, and she has stood much more service and encountered more dangerous conditions than would have been faced in crossing the Atlantic, thus justifying the hopes of her builders.

While Europe continued absorbed in the war, it remained for America to prepare for the great flight. Profiting by the experience of the past, a new airship was designed for the purpose. It was equipped with 6 twelve-cylinder motors of 300 horsepower each, with a total driving power of 1800 horsepower. This airship could carry a crew of six, and fly at a speed of about 100 miles an hour. It was calculated that the new airship would cross the Atlantic in about thirty hours. The aëroplane was especially de-

signed to alight upon the water and rise from it. In view of the length of the non-stop flights made on either side of the Atlantic by much smaller and lower-powered machines, it seems entirely reasonable to suppose that the transatlantic flight is assured.

The general rules for the flight as laid down by Lord Northcliff will doubtless be followed when the attempt is made. The entrant will give ample notice of his place for starting, and indicate, as nearly as possible, his landing-place. Only one aëroplane may be used for each attempt, and each must be so marked, before starting, that it can be identified on reaching the other side. Repairs may be made en route. No stop is allowed throughout, except on water. The start may be made from either land or water, but if it is made from the water the aëroplane must cross the coast-line in flight when the official time will be taken. A pilot may leave his aëroplane, but on resuming his flight, must start from approximately the same point. The finish may be made on land or water, but the flight will officially end and the time be taken when the aëro-

plane touches land or flies over the coast-line of the opposite side of the Atlantic Ocean. There are, at present, three projects under way for realizing the transatlantic flight, one by an American and two by Swedish pilots.

With the rapid development of flying has come a significant change in the attitude of the general public. The exhibition flights which once thrilled large audiences would scarcely cause the man in the streets to-day to turn his head. When Wilbur Wright first flew above New York during the Hudson-Fulton celebration, the writer was one of a great crowd that lined the waterfront to watch him. To-day the army aviators fly daily over the same course, and the busy crowds below scarcely give them a glance. The first exhibition of the new aircraft in America was an extremely modest attempt at flight. The air man, Henri Farman, contented himself with a few hops while thousands stood by and marveled. The public soon grew more exacting, however, and could only be attracted by daring tricks such as looping-the-loop, spirals and volplanes.

Presently even the attraction of these thrillers failed to attract the sophisticated public. At scores of public fairs and similar gatherings throughout the country to-day competitions and voting contests are held, the winner to be rewarded by an actual flight aloft in an aëroplane. The change in public taste is significant, since it shows the growth of confidence in flying. Thousands of people have thus become familiar with air-travel from experience, thus preparing the public for the air-lines of to-morrow.

Any devotee of the camera will find a unique pleasure in aëro-photography. Viewed from above every landscape gains new and surprising values. The most familiar scenes, by a curious trick of perspective, are completely transformed. A fascinating field of experiment in photography remains to be explored directly above our heads. With the progress of the war, aëro-photography has become a fine art. Fortunes have been spent in building special cameras to solve the new problems of air photography. The most approved type of hand-camera used before the war was found

An aëroplane camera with pistol grip

A remarkable aëroplane photograph of the trenches during a battle

to be inefficient under the new conditions. The Germans were the first to invent a camera with a pistol grip which could be aimed and "fired" with a single movement. Later a special camera, three feet or more in length, was devised which is set permanently in the floor of the aëroplane car. Still another camera has been invented in the United States in which a fresh film is placed in position and exposed by a single movement. By pulling a strap, ten pictures may be taken in a second and hundreds of exposures made without reloading. The air man in passing over trenches, for instance, may catch every detail of the earth below him, while keeping both hands free to operate his machine.

Successful photographs have been made at an altitude of more than two miles. By enlarging these negatives, a stretch of country may be mapped with amazing detail. The aëro-photographer has also solved many atmospheric problems which completely baffled him a year or so ago. He has learned to judge the value of mists or clouds and take photographs which would have been im-

possible in the past. It often happens, for instance, that the earth will be almost completely hidden at an altitude of one thousand feet while, by climbing a thousand feet higher, the camera will "shoot" through the clouds and catch perfectly clear pictures. The artistic possibilities of aëro-photography are still a virgin field. As the aircraft becomes more common and both amateur and professional camera men come to work aloft, the new photography will doubtless become one of the most fascinating of the arts.

An airship, by the way, especially when aloft, is the most democratic vehicle in the world. A sudden rise in altitude plays curious tricks with accepted social relations. To indulge in mixed metaphor, the aëroplane may be said to be a great leveler. From centuries of custom, the driver or footman of the ordinary land vehicle has come to be accepted as a menial, and his manners have grown correspondingly servile. On receiving an order he touches his hat, and stands at attention. An improvement may be noticed with the introduction

of the automobile. The chauffeur is more nearly the equal of the owner, and may even discuss problems of fuel or speed and hold opinions of his own.

Aboard an aircraft, for the time being at least, all class distinctions are forgotten. An American whose wealth and social position are famous on two continents recently made an air voyage with his wife to a high altitude. On meeting their pilot, both were extremely dignified and gracious. As the craft rose higher and higher, however, and the earth became a mere blur below them, social conventions began to relax. At an altitude of more than a mile, the pilot found it necessary to ask for directions.

"Pardon me, Mr. Blank," he began formally, "may I ask—"

"Oh, never mind that," interrupted the passenger hastily, "Call me Jim. My wife's name is Mary. What do you want to know?"

CHAPTER IV

AERO-EXPLORATION AND ADVENTURE

THE aëroplane is the ideal vehicle for the explorer. Instead of toiling laboriously through trackless wastes, the air man overleaps all obstacles, and traverses the most inaccessible parts of the globe at a pace which, to the explorers of the past, would seem magical. How many of us realize that only one seventh of the land surface of the earth has been scientifically mapped? The total land area, including the arctic and antarctic regions, is about 60,000,000 square miles, and there still remains 30,000,000 square miles of which our topographical knowledge is sketchy, and 8,000,000 square miles entirely unsurveyed and unmapped. It is estimated that, at the present rate of progress, this work will not be accomplished in less than two hundred years. With the aid of the aëroplane, the

world's survey may be completed in twenty years, adding vastly to our geographical knowledge, and saving an enormous expenditure of life and money.

The aëroplane doubtless will soon revolutionize all arctic exploration. Within a few years air men will penetrate the unknown regions within the arctic and antarctic circles and dispel the mystery of centuries. It has been estimated that an explorer, with the aid of a flying craft, could cover more territory in one day than could be explored by dog-sledges in two months. An attempt was once made by Walter Wellman to penetrate the polar regions by means of a dirigible balloon. A base was established on the coast of Norway, but after many trials the attempt was abandoned.

Profiting by this experience, the arctic explorers have decided that the ideal craft for such work is the hydro-aëroplane. Unlike the balloon, the aëroplane is not sensitive to extreme cold, and can negotiate high winds. The aircraft designed for arctic work is mounted on pontoons and runners instead of wheels, since it must rise and land from

ice or water. The hull should be covered with walrus hide to guard against damage from sharp pieces of ice. Exploration will be comparatively simple with such craft both over water and land. The aëroplane will sail quickly across seas of floating ice in which no vessel, however staunch, could live.

The pilots of these exploring planes, even when aloft, will be able to measure distances or determine their position with reasonable accuracy by scientific observations. With the aid of a watch and sextant it is possible to fix a position within two minutes of an arc, or about two miles. Such readings, of course, can be made while in the air. The air man will be obliged to enter on his log the actual speed of his machine which he calculates from the revolutions of his propeller. When flying for long distances over the trackless snow, there are naturally no landmarks. Allowance must be made for the drift of the machine, or the distance the wind carries it off its course. The drift-indicator which is now a part of the air pilot's equipment enables him to make corrections so ac-

curately that there is little chance for mistakes in flights of less than four hundred miles. The wind that blows over the level seas in these regions is not broken up by mountains and valleys, but flows steadily and can be definitely counted upon.

One of the most serious difficulties in aërial navigation in the arctic regions is the disturbing effect of the magnetic poles upon ordinary types of the compass. This will be guarded against by installing two gyroscopic compasses on each aëroplane, one to indicate the true north and the other the longitude. The importance of accurate observations cannot be exaggerated. In traveling hundreds of miles over trackless regions, it would be impossible, of course, for the air man to "blaze his way," as it were, or follow his own track in returning to his base. If he could not depend upon accurate readings to determine his position, he might become hopelessly lost.

The possibilities of aërial exploration of the arctic regions are almost boundless. A few days' flying would solve the century old problem as to whether a continent or an

archipelago occupies the region of 500,000 square miles between Alaska and the pole. It is believed by some explorers again that enormous deposits of coal may be discovered in this region. The direction of many mysterious currents flowing from the arctic regions could at last be determined by aërial exploration. An immense amount of invaluable information would be brought back concerning animal and plant life in these remote regions, and maps of the region could be definitely drawn.

The first polar explorations to employ aëroplanes will be those headed by Captain Amundsen and Captain Bartlett, now being organized. One of the expeditions will enter the polar region by way of Bering Strait, the other by a route north from Norway and the Kara Sea. Both parties will be provisioned for five years. It is believed that the aërial equipment will make it possible for the first time in history to complete the maps of the region covered. The aëroplanes will be employed in making surveys and for photographic work. A special effort will be made to determine the course

Crossing the snow-capped Alps

of the mysterious drift-currents, and it is believed that the two expeditions will be able to keep in touch with each other by means of aëroplanes. Should either of the ships be crushed in the ice, the crew of the wrecked vessel can be transferred to the other expedition and food and supplies exchanged by air-route. Admiral Peary looks forward to the day when the earth will be circumnavigated by aëroplane by way of the two poles.

The exploration of New Guinea, now being planned, also illustrates the possibilities of aëroplane exploration. The interior of New Guinea contains the largest area of unexplored territory to be found anywhere in the world. It is an easy matter to reach any point along its coast, but no white man has yet penetrated the region contained in a great square whose sides measure some 350 miles. Here are to be found the pigmy races known as the Taparo and Goliath dwarfs, and a curious mammal which hatches its young from eggs; and many little known natural curiosities.

The exploration of this region by aëroplane has been planned by the Swedish scien-

tist and explorer, Dr. Eric Mjoberg. The aërial distance from the coast of the island to the center of this unknown region is only about 230 miles. Dr. Mjoberg plans to establish one or more aërial bases on the coast, from which scouting expeditions will fly to discover landing places and sites for camps in the interior. Two aëroplanes will be used; one a high-powered machine, and a second, a lighter model. The large machine will carry five passengers and an additional load of 1000 pounds of supplies.

The exploring party will include several scientists, a map-maker, a moving-picture man, a taxidermist and many assistants. Once the main base has been established on the coast, the scouting planes will select the best sites for inland camps. A flight of a few hours will enable the map-makers to obtain his observations. The light machine will be used by the moving picture operator. The heavier machine will carry members of the expedition with their scientific instruments from the bases to the camps in the interior. The collections gathered inland will be carried back to the coast by aëroplane

where the taxidermist will continue his work, and the various specimens preserved and classified at leisure. The distances to be covered by the aëroplanes are comparatively trifling. The camps furthest inland will scarcely be more than two hundred miles from the coast, so that a flight of three hours or less will replace the tedious and dangerous journeys of weeks that otherwise would be required to penetrate these wilds.

Only by aëroplane could observations have been taken of the San Diego flood which later proved so valuable to the relief expeditions. The flood was caused by the breaking of a large dam, the waters behind it inundating an immense area with great loss of life and property. All ordinary means of communication was destroyed. Railroads were wiped out; and the telephone and telegraph lines went down. Relief expeditions were quickly organized, but none could reach the stricken area. After many efforts had been made to reach the district by automobile, on horseback and afoot, a flying-boat was pressed into service, and the desired information secured within an hour.

From this aëroplane which flew as low as two hundred feet, every detail of the flood was clearly visible. At times the machine rose to a height of two thousand feet from whence a panorama of the entire devastated area could be studied. The condition of the broken dam was ascertained and the exact course taken by the rivers that had swept the country. The air men flew above two valleys which had been inundated, and observed in detail the wrecked houses and abandoned ranches. Many bodies were seen floating in the flood or caught in the wreckage. At one point a number of survivors were discovered trying to save from the wreckage the remains of their houses. The air men ascertained where survivors were held prisoners by the water, and along which channel boats could proceed to help them. On returning, the air men were able to direct the relief work, thus saving many lives.

In the Mesopotamian campaign of the Great War, airships were used for the first time in history to carry food to a starving garrison. A British force at Kut-el-Amara was surrounded by Turkish forces and com-

pletely cut off from supplies. A fleet of aëroplanes was employed for nearly three weeks to fly from the nearest British base with food and mails, and, after dodging the Turkish fire, to drop the supplies from a point above the garrison. Only six machines were available and of these, two were of old types, but during the period from April 11 to 29, eighteen thousand pounds of supplies were actually delivered to the beleaguered garrison. During this time the Turks brought down but one aëroplane, the pilot being killed and the observer wounded. The supplies did not prove sufficient, however, and the garrison was lost. With the aid of a larger aërial squadron enough food and ammunition could have been transported to save the garrison.

During the East African campaign of this war, a British aëroplane, carrying a pilot and scout, was detailed to reconnoiter a German position more than one hundred miles distant, and far behind the enemy's lines. The flight to the objective and return must, of course, be made without alighting, or the air men would undoubtedly be captured,

The hostile aëroplane was closely watched by the Germans and repeatedly shelled. By rising to a considerable altitude and giving the batteries a wide berth, the air men managed, however, to dodge the thousands of bullets aimed at them, which in itself was a sufficiently perilous undertaking.

After a flight of one and a half hours, the objective point was reached in safety. Here a new danger confronted them. The aëroplane must be brought near enough to earth to make detailed observations, which naturally brought it within range of the trench guns. The scouts must depend upon their airmanship skill to dodge the enemy's fire. Flying at top speed, or better than a hundred miles an hour, the aircraft swooped down at a terrifying angle and, swerving suddenly to one side, again mounted rapidly, followed by a hail of bullets, until a safe altitude had been reached. So far the aëroplane had dodged every shot, and in high spirits the air men turned toward home and safety.

The scouting plane was flying at an altitude of seven thousand feet when its engine

suddenly went "dead." The pilot glided down as "flat" as possible, using every trick meanwhile to make his engine "pick up." Several miles had been covered without power and the aëroplane had descended to within two hundred feet of the earth, when the pilot found himself directly above some German trenches. Hundreds of upturned faces could be seen and several bullets rattled against the armored floor of the car.

The pilot still struggled with his engine. He had even looked below to pick a landing-place when the engine suddenly "picked up," the aëroplane darted forward and, in a moment, the trenches were left far behind. Five minutes later, however, the engine again stopped, and this time there was no escape. The pilot was obliged to land in an open space covered with tall grass. He "stalled" his machine, holding it off the ground until it had lost all flying speed, but at the last moment it side-slipped and broke a wing in landing. Both airmen alighted without injuries, but the aëroplane was now useless. Measured by the speed of their machine, the air men were but thirty min-

utes from safety, but the fifty miles that separated them from the frontier, negotiated on foot, proved a formidable barrier. For two days they wandered through the jungle without food or water, their clothes torn to rags. On the afternoon of the third day they staggered into a kraal, and covering the natives with their revolvers, demanded food. A runner was despatched who returned in a few hours with assistance. Next day the air men returned to their machine and, after hasty repairs, succeeded in flying back to their base.

One of the most valuable services of aëroplanes in the Great War has been their assistance in spotting the fall of shots. In countless battles both on land and sea they have served as the eyes of land batteries or war ships, thus greatly extending their range of vision. From their position high aloft, perhaps directly above the target the aëroplane pilots observe the effect of the fire, and give minute direction for altering the range. Such observation was inconceivable in warfare until a few years ago.

Although valuable observations have been

[illegible] viewed from above

made from aëroplanes and balloons in the past, it was practically impossible for the observers to communicate with their bases without serious delays. The use of wireless electricity has changed all this. As late as 1914, or the year before the War, the wireless outfits were bulky affairs, weighing from three to five pounds for every mile of transmission. The aëroplanes of that period could carry comparatively little weight so that wireless apparatus of effective range could not be taken aloft. The system has been so perfected that to-day the wireless sets weigh only one pound for every mile of transmission, and the carrying capacity of the aëroplanes meanwhile have been greatly increased.

A striking example of this service of the aëroplane is afforded by the attack on the German cruiser *Königsberg* in July, 1915. The cruiser had taken refuge in the Rufigi River in East Africa, where it was completely hidden by tropical foliage. The British Monitor *Savern* engaged in the attack sent up a scouting aëroplane and directed its fire entirely by the advice of the

air pilot. The first shots fell wide of the mark, but the aëroplane observer aloft was able to report the effect of each shot almost instantaneously. The range was quickly found in a few minutes and eight of the next twelve shots took effect, putting the cruiser out of commission and setting her on fire.

The use of aëroplanes by our coast-guards will doubtless effect the saving of hundreds of lives every year in sea disasters. A careful analysis has been made of wrecks along the Atlantic seaboard during the past year to determine the usefulness of air craft. The coast-guard cutter *Onondaga,* which patrols the coast from Cape Hatteras to Delaware breakwater, responded in one year to eighty-three calls for help. In thirty eight of these wrecks the aëroplanes would have been invaluable in saving life and property. The Acting Secretary of the Treasury, Byron R. Newton, proposes to establish ten aviation stations along the Pacific, Gulf, Atlantic and Lake shores where the statistics of maritime disasters show these to be most needed. The air men will supplement

the work of the coast-guards already established. It is proposed to use high-powered air-boats for this service which can fly in high winds and land upon the water alongside ships in distress. These boats can carry a score of passengers and would be invaluable in life-saving.

CHAPTER V

AERIAL TRANSPORTATION

IN a great national crisis, a threatened invasion for instance, a quorum of Congress might be assembled in an incredibly short time by the general use of the aëroplane, thus saving priceless minutes. The first official flight to Washington was made by Congressman O. D. Bleakley, of Pennsylvania in the autumn of 1916. Driven by Sergeant Ocker of the Flying Corps, Mr. Bleakley took the air at Philadelphia at two-thirty one afternoon, flying at an altitude of about a mile. The distance from Baltimore to Washington was covered in twenty-five minutes, making less than three hours for the entire trip. The landing was negotiated without mishap on the polo grounds. The congressman, who is over sixty years of age, was enthusiastic about his flight, and prophesied the common use of the aëroplane by

busy people who are in a hurry. It is interesting to recall that George Washington was severely criticized, even ridiculed, for once prophesying that the time for carrying the mails between Philadelphia and New York, then the national capital, might some day be reduced to less than twenty-four hours.

The first aërial fleet to go aloft on a pleasure cruise in America was the "football special" which flew (1916) from New York to Princeton, New Jersey. The squadron comprised twelve passenger-carrying aëroplanes driven by Government pilots. Ten of the machines rose from the Government aviation field at Mineola at one minute intervals. On climbing to an altitude of one thousand feet, they circled about until all were aloft, when Lieutenant Kilner, the commanding officer of the squadron, signaled for battle formation. The fleet quickly fell into line, and in a few seconds shrank to the size of a flock of swallows and disappeared. Two other machines with passengers stood waiting at Governors Island, and, on the first appearance of the main fleet, rose to join them. The flotilla hovered

over New York harbor for a few moments until the new-comers had taken their positions in line, when the flight was resumed.

Throughout this trip only two of the machines were forced to alight and none experienced serious difficulty. One of the flyers, Lieutenant William Thaw, had some minor engine trouble and volplaned to earth near Flushing, but soon rose and resumed the flight. Another aviator became separated from the squadron, lost his bearings and soon found himself approaching Atlantic City, which is separated from Princeton by the entire width of the State. Such was the speed of the air men, however, that all reached Princeton in time for the game, where their regulation leather coats and flying suits attracted great attention. The flight had a more serious purpose, however, than the pleasure of attending the foot-ball game, since it served as a military test for cross-country work.

A squadron of twelve army aëroplanes flew, a few weeks later, under severe weather conditions over the Government course between Mineola station near New

York and League Island Navy Yard at Philadelphia. The thermometer at starting registered ten degrees, but aloft the cold was intense and a gale which blew in the high altitudes severely tested the airmanship of the pilots. The squadron flew at a height of about five thousand feet, covering the distance of 115 miles at a speed above one hundred miles an hour. The air men were covered with ice and had to be literally thawed out before they could be freed from the pilot-seats.

A heavy mist completely hid the earth from aloft, and even on descending to lower levels, the snow which blanketed the country obliterated every landmark. Several of the aviators failed to recognize any city or town over the entire distance. The course had to be steered entirely by compass and other instruments used in air navigation. Nevertheless the squadron followed the invisible course with wonderful accuracy. Despite the unprecedented difficulties, the distance between New York and Philadelphia was covered in about half the time made by the fastest trains.

THE AIR MAN

How simple a matter a long city-to-city flight has become is shown by the New York to Washington trip made by Mr. Alan R. Hawley, President of the Aëro Club. The start was made shortly after seven o'clock one clear morning from Sheepshead Bay near New York. Just as a carrier-pigeon first circles about to get its direction, the aëroplane rose in great circles, quickly climbing to an altitude of six thousand feet. On the third circle at 7:23 A. M., the pilot turned his craft southward. New York harbor lay in a great panorama far below as they swept across the Narrows, skirted the Staten Island shore and gained the mainland at Perth Amboy.

The cities along the route were reached in swift succession. "We had barely passed a city," says Mr. Hawley, "and I would be looking for prominent landmarks and studying the topography of the land for future use, when another city would loom in sight and we would quickly pass it." Following the railroad tracks, the aëroplane had soon left Trenton behind, and in an incredibly short time was flying

Looking down on forty centuries

smoothly over Philadelphia. The wind which had retarded the flight at first, changed to shifty currents just outside of Baltimore. This was the only rough weather encountered. So rapid was the flight that within five minutes after passing over Baltimore the Washington Monument was sighted. A perfect landing was made on the polo grounds, when Mr. Hawley proceeded at once to call upon President Wilson, Secretary Daniels and other officials. The entire flight of 237 miles was made in 184 minutes, establishing a new record between the cities.

The air man is constantly finding new lines of activity, usually highly profitable, for his skill and courage. In South America the aëroplane has been used with great success in surveying remote areas, where its speed readily outclasses the laborious chainmen. An enterprising mining company in Mexico is about to utilize aëroplanes for carrying ores under unique conditions. The ore is mined at an altitude of some ten thousand feet, and carried to the valley below by pack-mules. The mules

carry only small loads, two thirds of which consist of fodder and provisions. Several days are required to wind down the tortuous path on the mountain's sides. The aëroplanes can volplane to the valley in a few minutes, and have no trouble, without their loads, in reaching the ten thousand foot altitude.

The herds of cattle which graze on the great 187,000-acre San Cristobal Ranch in New Mexico, once required the attention of one hundred and fifty cowboys. By using automobiles the herding was done as well by seven men. The management is now installing air men, whose vastly superior speed will "round up" the most widely scattered herds with great saving of time and money. A great future is prophesied for the aëro-cow-puncher.

The first aërial lineman started on his unique round of duties more than three years ago. An experienced air man, Robert G. Fowler, was engaged by a power company in Sacramento, California, to carry an expert once a week to inspect two divisions of wire lines some sixty-eight

miles in length. The wires are strung over several valleys, the deltas of the Sacramento and San Joaquin Rivers, and into the Contra Costa Range of mountains, where their elevation is at times two thousand feet. A large force of men had previously been required to patrol the lines, looking for broken insulators, fallen wires, and other damages. The work was done much better by a single aërial lineman. It was found that a broken insulator could be discovered while flying at an altitude of one thousand feet.

The first commercial air line in America, if not in the world, was established early in 1914 between St. Petersburg and Tampa, Florida. Four regular trips were made daily, the rate being five dollars for a single trip and ten dollars for a return-trip ticket. The regular route by steamer between the two points was about fifty miles, and took three hours. The distance by the air-route was but nineteen miles, which was covered on regular schedule in twenty minutes. The time tables contained the following interesting announcement:

Passengers are allowed a weight of 200 pounds *gross* including hand baggage, excess charged at $5. per 100 pounds, minimum charge, 25 cents. *Express rates* for packages, suit cases, mail matter, etc., $5. per 100 pounds, minimum charge, 25 cents. Express carried from hangar to hangar only, delivery and receipt by shipper.

An aëro-postmark on the stamp of our letters will soon be a commonplace. Within a year or two we will probably be measuring the time for the transportation of mails by the speed of the aëroplane, instead of the express train. Letters have been carried experimentally by the air-route for thousands of miles. An appropriation of $100,000 is now being considered by Congress for experimenting with aëro-mail service. The aëro-mails will make almost as great an advance upon our present express-train service as steam travel improved on the primitive mail-coach.

The first aëro-post stamps were issued in 1912 in the United States, Argentina and Austria. The American stamp, which doubtless will some day be priceless, was sold for twenty cents. It bore the title, "U. S.

Parcel Post. Aëroplane Carrying Mail," with a picture of an aëroplane. As a matter of historic interest, the first experiment was made at Nassau Boulevard, Long Island, on September 23, 1912. A number of isolated experiments followed, but it was not until February, 1916, that the Post-Office Department advertised formally for bids to carry mails by aëroplane. Eight routes were specified as available, one in Massachusetts, and seven in Alaska.

The proposed Massachusetts aëro-post route between New Bedford and Nantucket is some fifty-two miles by air line which, under ordinary conditions, takes from five to six hours to cover. By aëroplane post the average time of transmission would be less than fifty minutes. The maximum load of mail between these points is three thousand pounds, which could readily be carried by two hydro-aëroplanes in six loads of five hundred pounds each.

The saving of time over the Alaskan routes, where mail is often carried by dog-sleds, is even more striking. There are seven routes in this region, from two hun-

dred to three hundred miles in length, where one thousand pounds of mail is carried twice a week. In several cases a hundred hours is required for the trip which the aëroplane could readily travel in as many minutes. Since the appropriation for the service is often as high as $25,000 a year, it is obvious that the aëroplane could be profitably employed. A passenger-carrying service might also be introduced in this region, even at the present rate of travel. Over most of these routes, a seat in the stage-coach costs one hundred dollars, while sleeping quarters along the road are from five to ten dollars a day. The time saved by an air-service would solve many Alaskan problems.

The first air-borne mail to pass between Chicago and New York was delivered on December 3, 1916. A mail-pouch with more than a thousand letters and post-cards was carried by Victor Carlstrom, whose actual flying time between the two cities was 8 hours, 28 minutes and 30 seconds. Over part of the route, the mail was carried at a speed of 134 miles an hour.

When the mail aëroplane came to earth

at Governors Island in New York harbor, it was received officially by Assistant-Superintendent of Mails John W. Tiedamann and rushed to the New York post-office. Many of the letters to local addresses were delivered by special messenger within half an hour of the landing of the aëroplane. This historic mail contained letters from prominent Chicago officials to President Wilson, Theodore Roosevelt, Thomas Edison and others. One package of letters was despatched by the submarine-liner *Deutschland* to Germany.

The first scheduled aëro-mail-service will probably be established between New York and Chicago. The experimental stage is past. Officials of the Post-Office Department have estimated that a load of mail in this aëro-service may weigh from five hundred to a thousand pounds. In the beginning, only first-class mail matter will be accepted for aëro-delivery. The mail route between the two cities, measured as the crow flies, will be seven hundred and twenty miles in length instead of one thousand miles by rail. Judging from the time already estab-

lished over this route, the mail aëroplanes will cover the distance in from six to fourteen hours, with an average time of about eight hours. To meet the demands of business interests in the two cities, it is planned to have the mail transported at night. A letter mailed before six o'clock in the afternoon in either city would thus be delivered before nine the following morning. Under very favorable conditions, it will reach its destination shortly after midnight.

The best route for the aëro-mail-service has been selected with great care. It is planned to establish three relay stations, one near Williamsport, Pennsylvania, another at Niles, Ohio, and the third at Napoleon, Ohio. Extra machines will be held in readiness at these stations with materials and tools for making repairs, as well as fuel and all necessary supplies. To save every possible second in these flights, aëroplanes will stand in readiness with their propellers spinning, so that the moment a mail aëroplane arrives, the pouches will be transferred instantly to a new machine and be in the air again with only a few seconds' delay. The

A passenger Zeppelin aloft

Near view of a Zeppelin's cabin

relay-station will be marked by powerful guiding lights, visible for many miles. It is even planned to establish lights every twenty miles along the entire course so that the mail aëroplanes will not lose their way. Several aëro-mail-routes will doubtless be in operation within a few months.

The aëro-mail-service will doubtless soon be followed by regular passenger transportation over the same route. It has been estimated that a regular passenger air-service between New York and Chicago could be maintained to-day if passengers were willing to pay $250 each for the trip. In time, the mail rate for long distances will be much less than that of taxicabs at present. The great expense at present is due to the high pay demanded by air pilots who are capable of driving aëroplanes for this distance. In the course of a few years the supply of air-pilots will naturally meet the demand. We can all remember the early days of flying when a fee of several thousand dollars was demanded by an aviator for flying a few miles. To-day thousands of air pilots are engaged in the aviation corps of many

armies at small salaries. It is safe to prophesy that these chauffeurs of the air may be hired within a few years at a cost of around fifty dollars a week. Regular passenger air-traffic, therefore, seems assured in the near future at mileage rates which may compete successfully with those of the railroads.

In planning cities in the future, provision must be made for suitable aërodromes. Within a few years, aërial passenger and freight travel doubtless will be of such volume that suitable landing places will have to be provided regardless of expense. Modern cities, for example, have been allowed to grow without any provision for railroad terminals in central locations, and enormous expense has been incurred by running tracks through crowded districts. It will soon be as important to have the great aërodromes convenient to the hotel, shopping and theater districts of cities as are the railroad terminals to-day. In making an air trip between New York and Philadelphia at present, more time is required to travel from the central districts to the outskirts of the cities where

the aëroplanes can rise or land, than is required to fly the ninety miles between the two cities. The city aërodromes must be accessible at least to the street-railways and within convenient motoring distance by taxi-cab to the hotel, business and residence sections. The size of these aërodromes will depend largely on the development of the air-craft and its ability to hover in alighting.

It is estimated that an aërodrome from two hundred to three hundred acres in extent would suffice for a comparatively large city. They will be equipped with hangars to shelter aëroplanes, and have repair-shops and supplies of gasolene and oil. Such plans are no longer the dreams of romancers. Many European cities have already found it necessary to build public hangars to accommodate their air-commerce. The air-traffic of the future may be expected to have an important influence upon the planning and general development of cities. The cities dating from the Middle Ages grew up about some central fort or stronghold and were crowded to keep within their walls or fortifications. Now that cities may be attacked

from above, provision must be made to defend them by air-craft, and the position of hangars and aërial defenses will play an increasingly important rôle in future.

A special map is required to guide the air man in cross-country flights. In Europe the aëronautic map has already received a great deal of attention. As early as 1911 a conference was held in Milan at which Rear-Admiral Peary represented America, and a second conference at Vienna in 1913 adopted important resolutions for the guidance of pilots. It was decided that the best scale for such maps was 1 to 200,000, and that all waterways should be colored blue. A number of conventional signs were suggested for indicating railroads, hangars, aërodromes, fortresses, castles and cathedrals. It was agreed that the country should be charted, and that each chart be named after some prominent local feature and contain the correct latitude and longitude. It was suggested at this international congress that red marks or danger signals be placed on localities which appeared safe landing-places from above, but

which were really dangerous. A steep, green slope, for instance, would appear flat to the pilot and might lure him down from his flying level. These red signals would appear on both the scale and photographic maps.

In addition to these small scale maps, it is desirable that the air man have more detailed photographic maps of the region he intends to fly over. Such maps should be carried out in natural colors, and to avoid confusion, there should be a winter map and a summer map, since the color of a landscape changes with the seasons. A familiar landscape may be completely transformed in appearance when seen from aloft, and a pilot might lose his way, even when flying over a well-known region. A mountain or a building, which would serve as a landmark for the motorist or pedestrian, might appear so flattened out, seen from a high altitude, that it would be valueless. A small pond of water which reflects the light would make a much better guide-post.

The general board of the United States Navy has advocated the preparation of spe-

cial aëro-maps of our coast for the use of naval pilots. One plan is to place signals at intervals of one degree along the shore-lines which could be recognized at an altitude of from a thousand to ten thousand feet in fine weather. The number of degrees might be indicated by flower beds or groves of trees. In patrolling the coast, the pilots could thus fix their position accurately at a glance.

The survey of an air-route is much more complicated than the layman imagines. To find the shortest distance route between two cities, for instance, the line must be laid out by magnetic compass. The true heading from city to city is found by projecting the line of flight between the two points, and correcting the variation due to the difference between the geographical and magnetic poles. The course to be flown is indicated on the map by arrows. It is planned to place sign-posts or light-houses along the route which may be readily recognized, even from high altitudes. Such maps enable the air men to travel from city to city over the shortest possible route and save many miles

of flying. The cross-country aëro-routes will some day be as familiar as are the motor tours to-day. A special aëro-map-holder has been invented in which a long map is rolled on two spools and held rigidly on the aëroplane, convenient to the pilot. The map is moved by turning the knobs of the rollers.

Let us suppose that an air man leaves New York westward bound. A number of maps are already available indicating the most favorable air-lanes between American cities. With his eye on the roller-maps mounted before him, the pilot may steer his craft with the accuracy of a homing-pigeon. Should he wish to call at some intermediate city on his western cruise, such as Buffalo for instance, his map will tell him the exact point at which he must alter his course. On reaching this point, he lays his course to the point of the compass indicated on the map and proceeds in a perfectly straight line. He may be flying at night above the clouds or over unfamiliar country and still be confident that his course will bring him to the landing-place indicated on the map by the shortest possible route.

THE AIR MAN

With serene confidence in the future, a great transcontinental air-route has been definitely planned, to be known, very fittingly, as the Lincoln Airway. This great project, originated by Mr. Henry Woodhouse, will doubtless be completely mapped within a few months. The invisible air-lane will start from New York and follow the shortest possible route to San Francisco, with side routes to many cities. Even to-day, it is believed that the distance could be flown in less than seventy hours. The project makes a strong patriotic appeal. Along this great artery of travel will soon sweep the great air-fleets of the future—countless air-craft carrying mails, passengers and freight with incredible swiftness, like innumerable shuttles weaving the furthermost cities of the country more closely together.

Aviation will lend wings to the millions of freight and passenger railroad cars, and every manner of sea-craft, and by annihilating distance and time, give to all manner of transportation an impetus scarcely conceivable to us to-day. The enormous ex-

An American aëro limousine

penditure of time and labor in constructing roadways, tracks, bridges and canals will be largely eliminated. A distinguished South American engineer recently visited America to interest capital in railroad building. He returned an enthusiastic advocate of the use of the aëroplane for practical transportation. To connect two cities five hundred miles apart in his country would require ten years of labor in bridging and tunneling, and many million dollars of expense. He discovered that for $100,000 he could establish an aëroplane service between the cities within a few weeks.

It is easy to recall the days, less than two decades ago, when the automobile was a curiosity. The development of the aëroplane will be scarcely less rapid or general in its influence. One of the early applications of the freight-carrying aëroplane promises to be in bringing perishable produce, such as milk, vegetables and fruit from the country to the city. Since a farm one hundred miles away will be scarcely an hour's sail distant, the problem of supply will be wonderfully simplified. Within a

few years, the cities will awake without surprise to see the countless sails of the food-fleets winging their way from every point of the compass.

CHAPTER VI

EMBATTLED AIR-FLEETS

WHAT country holds the mastery of the air?

It is a simple matter to compare the total tonnage and gun-power of one navy with another, and determine which country rules on the seas. On land, the size of an army and the strength of military vantage points naturally indicate which is the superior power. Many new factors must be considered, however, in measuring the power of an aërial navy. The relative fighting strength of the dirigible type of fighting craft and the aëroplane are bitterly disputed. Neither type has reached its final stage of development. It is impossible, of course, to establish a fixed base in the air comparable to the naval base of a land fort. The effective range of all kinds of aërial craft, again, is comparatively limited. The vic-

torious air-fleet which may sweep the sky at one hour, must return to earth or perhaps withdraw to a distant base, leaving the air unprotected and at the mercy of another hostile fleet.

The German air men claim they hold the mastery of the air by the strength of their Zeppelin fleets. They base this claim on the fact that their squadrons, sailing at a height of one mile, develop a speed of eighty miles an hour with an effective radius of one thousand miles and drop two tons of explosives, meanwhile repelling all attacks. The air navies of the Entente powers, on the other hand, point to the number of their war aëroplanes, whose greater mobility, they claim with a measure of justice, gives them control of the air. The aëroplanes have twice the speed of the Zeppelins, they argue, and can rise to a far higher altitude, bringing greater gun-power to bear from more advantageous positions. The rules of military science, it will be seen, are of little value in solving this new problem of the air.

An aërial battle-line of defense is much the same as an ordinary fortification, except

Unusual photograph of a Zeppelin at sea

that it is placed, as it were, on edge. At an altitude of about thirteen thousand feet, or two and a half miles, a number of swift, alert fighting-machines are constantly patrolling back and forth on the lookout for the approach of an enemy. This "ceiling work," as it is called, is most important for, from so great a height, they look out for miles in all directions. Lower down, only a mile or so above the earth, the heavier aëroplanes, carrying aërial artillery, fly back and forth, ready at a moment's notice to dash into battle formation and attack or repel the enemy. Along the battle front, still lower down and spaced at regular intervals, float the captive balloons—mile after mile of them as far as the eye can see. They sway at the end of long tethers day and night, while from their cars alert lookouts sweep the sky for the sails of the enemy, or watch the movement of troops, any movement of artillery or change in the system of attack.

From the scouting planes which may be out of sight far above, the pilots make reports to bases at regular intervals by wire-

less telegraph. The cars of the captive balloons are connected with the earth by telephone, so that the commanding officers look down upon the enemy with scores of eyes. Let an attacking fleet of aircraft approach, and their movements are reported at military headquarters within a few seconds. Time is priceless. Within easy striking distance, hundreds of aëroplanes—the light flying craft and the heavy artillery planes—stand ready to take the air at the first danger signal. One of the most important services of the observation craft is to assist in the fire-control. The pilots observe where the shells from their own batteries strike by the puffs of smoke or spouts of earth which follow each explosion. This information is flashed by wireless to the batteries and the range is corrected.

The aërial defenders of great cities like London and Paris are in constant communication, day and night, with the wireless scouts on the border frontiers. It is practically impossible for a fleet of aëroplanes or Zeppelins, to cross the frontiers without being observed by the aërial scouts, and the

defenders can always count upon at least an hour to take the air in defense. There are always some fifty aëroplanes, both scouts and artillery craft, in the air above Paris. A pilot remains aloft on scouting duty for about three hours when he is relieved, another plane rising to take his place the moment he comes down. A fleet of fully two hundred military aëroplanes is always ready, at a moment's notice, to take the air. In the early days of the war, French fleets proved almost helpless against the Zeppelins. The largest guns they could mount were unable to bring down the giant gas-bags. This difficulty has been solved by devising a flying bomb which ignites on striking the gas envelopes.

The first great air-battle in history was fought by German and British aërial fleets near Bapaume, one of the objective points in the great battle of the Somme. The British squadron comprised thirty planes, while the Germans mustered forty aëroplanes of various types. As the two fleets came together, a strong westerly wind, which continued throughout the engagement, drifted

them over German territory in the direction of Voulx-Vrancourt. The English had not chosen their battlefield, or rather air-position, and thus fought at a disadvantage. In an air-battle, every combatant who is forced to descend within the enemies' lines, however slight his injuries, is likely to be made prisoner, and therefore cannot rejoin his forces. It is impossible, besides, for an air-squadron fighting above an enemy's territory to count their losses or the enemy's with accuracy. When an aëroplane drops out of the fighting zone, they cannot tell if its pilot has been forced to descend for temporary repairs such as engine troubles, or has "plunged," losing his life and his machine.

The English armored "bombing" planes, carrying machine-guns and massed as closely together as possible, were flying at a prearranged altitude of about five thousand feet. The scouting planes, thrown out in advance, darted about somewhat higher. As in most aërial encounters, once the enemy's fleet was sighted, there was little or no time for manœuvering. The two hostile air-squadrons flew at one another at a speed of about

Placing a bomb in position beneath an aëroplane

one hundred miles an hour. Within a few seconds after the scouts had given the alarm, the battle was on. Neither squadron hesitated for an instant, but drove headlong at one another. The scouting planes had only time to swoop down to the mile-high level where the general engagement was fought.

In the mass of swirling, darting aëroplanes, it was impossible to count the enemy's forces, though it was generally agreed later that the German squadron numbered forty machines. It was out of the question, in such a hit or miss encounter, to follow any formal system of military evolution. The battle raged for twenty minutes. Neither the pilots engaged nor the observers a mile below could give any detailed description of the fight. Each pilot had to watch his own machine and, while he maintained a delicate balance, was obliged to dodge or attack his nearest antagonist as best he could, delivering as many blows as possible. Now it was a headlong plunge and a single shot, now a dip and a swerve to dodge the onrush of an antagonist. In some daring loop, the pilot would catch a fleeting glimpse

of his adversary and, with consummate air-manship, regain his balance and bring his rapid-fire gun into play. Throughout the battle, there was an inextricable tangle of darting, swerving machines, while the air vibrated to the continuous rattle of the machine-guns and the roar of seventy propellers.

The quick, darting movement of the embattled aëroplanes has been compared by observers of these encounters to the flight of wasps, while the roar of the propellers far aloft has the droning sound of bees. At an altitude of a mile or more, it is impossible to recognize the nationality of the fighting planes, and to tell friend from foe. The observer can rarely tell which is having the better of the encounter. It is only when a death-blow is struck that the observers below may be certain of the manœuver. The fall of a plane from the fighting zone is a sight never to be forgotten. The tiny, black speck which has been darting restlessly back and forth comes to rest for a moment, then falls. As it descends in a line drawn perpendicularly against the sky, it gathers mo-

mentum, trailing a black streamer of smoke behind it.

The first aëroplane to be shot in a vital spot was a German Fokker which whirled giddily for an instant, then burst into flames and crashed downward. Soon after, a British plane was badly injured and drifted out of sight. None could tell if its pilot reached the earth dead or alive. Two German planes shortly afterwards came to grief. Thousands of shots, meanwhile, riddled the wings of the planes, but few could be expected to strike vital parts. Both the German and British pilots drove and dodged with superb skill and daring.

In counting the cost of the battle, the observers agreed that six German aëroplanes fell, out of control, during the engagement. So severe was the fighting that they could not be watched until they landed. Some of these may have volplaned for several miles and reached the ground in safety. Of the British squadron, nine planes were driven down in hostile territory, three of which were known to have been destroyed. A German kite-balloon was also driven down

in flames. When a roll was called after the battle, seven of the British machines were reported missing. Two British airships, returning from the battle, brought wounded pilots, and one succeeded in bringing back a gunner, shot dead in mid-air. One, with badly crippled wings, fought its way against contrary air-currents to land safely within the English lines. Whatever its casualties, the German squadron withdrew in good order, leaving the enemy in undisputed possession of the air.

Many spectacular engagements have been fought directly above the trenches. Neither the soldiers in the trenches nor the air men may find time to watch each other, yet for each a marvelous picture is presented. The air man can look down upon the greatest armies ever assembled in their mighty struggle. From the ground, the varying fortunes of the aërial fleets present an amazing spectacle. An English officer in a letter written at the front gives a vivid picture of one of these air-battles. Several German war planes were seen one day approaching the Allies lines at high speed. With the aid

Aiming an anti-aircraft gun

of glasses, the black crosses on their wings could be clearly distinguished. Their object was, naturally, to spy on the enemy's forces and report any important movement of troops or the shifting of siege-guns.

They were still at some distance, when a fleet of British planes rose to meet them. The attack was expected, for a warning of their approach had been given by microphones which detect the whir of the propellers many miles away. As the two fleets approached, the sky seemed dotted with black shapes, and soon a faint popping noise told the observers that the duel had commenced. From the ground, more than a mile below, it was impossible to tell the German from the French planes, and the two fleets soon formed a darting, swirling group. It seemed hours, though only a few minutes passed, before one of the planes suddenly burst into flames and fell, trailing behind it a long plume of black smoke. As the battle progressed, three more planes were seen to fall out of the fighting zone, but they remained under control, as was shown by the skill with which they volplaned to earth.

One of them came down inside the British lines and was quickly surrounded by soldiers, anxious for news of the battle being waged above their heads.

The fight continued for fifteen minutes. A second aëroplane was soon seen to be shot down, falling inside the German lines, but its nationality could only be guessed. The battle seemed to be fought within a circle scarcely a mile in diameter, and at times the aëroplanes appeared to almost touch one another. The Germans were determined, at any cost, to gain the coveted information, while the British were no less stubborn in guarding the invisible boundary line of their frontier. Meanwhile, news of the engagement had been rushed to the nearest French aviation camp, and reinforcements were soon on the wing. It was said that the French fleet comprised several American air men.

The French fleet was soon visible at a great distance, a mere cloud of small, dark objects resembling a swarm of bees. It grew rapidly larger and soon the whir of propellers was added to the clatter above.

As they approached, they divided into two groups, attacking the German fleet from two sides. The reinforcements turned the tide of battle. The German fleet was now greatly outnumbered, but continued to fight for several minutes. Two more planes had been forced to drop out of the fighting-zone, when the Germans gave a signal to retire. The diminished fleet drew together and retired in good order.

CHAPTER VII

AERIAL BATTERIES

THERE are at present, according to belief, more than 30,000 aëroplanes in the service of the several embattled armies of Europe. Germany alone, it is said, has not less than 9000 fighting aircraft. War planes are now in active service mounting six machine-guns of three inch caliber, and carrying aloft a ton of ammunition. These great aërial fleets are engaged in reconnaissance and observation, as well as in active offensive and defensive operations. In the first two years of the war, German battle-planes and anti-aircraft batteries alone destroyed more than 1000 aëroplanes, or 167 squadrons of six machines each. In a single year, Great Britain spent $500,000,000 on her air-division.

The battery of a war-plane usually consists of machine-guns of small caliber

Defending an air attack at sea

Infantry repelling an air attack

mounted directly in front of the pilot's seat. The crew may consist of two men, the pilot and the *tireur,* or gunner, though it is common for one air man to guide and fight with his machine. The difficulty of serving a gun under such conditions is, of course, unprecedented. Since the two planes engaged may be flying at a-hundred-miles-an-hour clip or faster, they will change positions so rapidly that a gun mounted in the conventional way would be useless.

A very simple device has been invented for mounting the aëroplane batteries. It consists of a stout, metal ring about two feet in diameter, placed at the prow of the aëroplane at the height of the *tireur's* shoulders. The gun rests on the rim of this ring, so that it is quickly shifted to point at any angle, and may be swung up or down through a wide vertical range. The *tireur,* standing inside the circle, can easily balance himself, however his craft may dip or climb. Even in looping-the-loop, when the gunner is almost upside down, he can continue to aim and discharge his battery. Some of the planes carry a special sighting apparatus di-

rected by means of a drift-indicator. The battery often includes, besides, an ordinary service-rifle which may be used in defending the plane if it be forced to come down in enemy territory.

The military aëroplanes are practically all of the tractor type, with the propeller placed in front of the machine. While a gun can be brought to bear in any direction, it was at first impossible to shoot directly ahead through the circles described by the revolving propeller-blades. It has been calculated that a bullet fired through this circle would only hit the propeller once in ten times, but a single shot might disable the blades and play havoc with the aëroplane. To overcome this fault, an ingenious device has been invented by which the firing of the gun is controlled by the shaft of the propeller, which discharges it at the instant the bullet may pass the revolving blades without striking them. The pilot can thus shoot straight ahead without endangering his propeller. A war-plane frequently carries one thousand rounds of cartridges on one of its raids.

AERIAL BATTERIES

The so-called "bombing planes" usually carry artillery shells of about six-inch caliber. The gas-bands have been removed, and the ends fitted with torpedo-like tails. They may therefore be thrown overboard or discharged from their tubes upside down, and, in falling, will quickly right themselves. The bombs are released by pulling levers convenient to the pilot's seat, or by a pedal arrangement operated by the feet. This mechanism enables the air man to keep both hands free to make observations and to steer his machine. It is much more difficult to strike a given target from a high altitude than might be imagined. The bomb, in falling from a machine in rapid motion, does not descend in a straight line, but describes a parabola which is further affected by the force of the wind.

So much depends upon the air man's skill in aiming, that he is required to practise for weeks with an elaborate bomb-dropping apparatus. He works from a seat raised on poles about twenty-five feet above the ground. Beneath him, a landscape, painted on canvas and mounted on rollers, sweeps

backward exactly as the earth passes below an aëroplane in flight. The picture is wonderfully complete, with military camps, towns, railroads and bridges. The air man, with the aid of his range-finder, selects his target in the flying "landscape," makes allowance for the effect of speed, height and wind, and drops his "bomb" with mathematical accuracy. A series of mirrors connected with the range-finder proves of great assistance in aiming.

A bombing-plane will frequently carry more than three hundred pounds of high explosives. To avoid accidents which would be especially disastrous in mid-air, the contact or detonating fuses of the shells are "dead." Their mechanism, however, is connected by a wire with crosspieces inside the car so that, when the shell is released, it becomes "alive" and is exploded on striking the earth. The pilot, or *tireur,* comfortably seated in his aëroplane, by a pressure of hand or foot, can direct a devasting fire upon the enemy a mile below. The bombs are usually discharged one at a time, although some bombing-planes are double-barreled

Searchlights guarding London against Zeppelin raids

and permit two bombs to be released with a single movement.

One of the most dangerous weapons yet devised for the aëroplane is the *flêche* or steel dart which is showered upon the enemy from great altitudes. The *flêche* resembles an ordinary pencil in shape and size. It is sharply pointed at one end and weighted so that it will fall in a perfectly straight line. In dropping a great distance, perhaps several miles, it develops, of course, a high velocity and will pierce an ordinary defense like paper. One of these darts struck a soldier on horseback and passed through the man and his horse. Good specimens are rare since, if they strike a rock on reaching the earth they buckle or are broken, and if they come down on ordinary soil, they bury themselves to a depth of several feet.

A deadly efficiency is promised for a new type of air-warcraft known as the torpedo-plane. Rear Admiral Fiske has devised a mechanism that holds the regulation Whitehead auto-torpedo rigidly beneath an aëroplane and discharges it by pulling a

lever. The aim is wonderfully true, and the torpedo speeds on its way as effectively as if launched from a regular destroyer. The pilot of the torpedo-plane approaches his target, a great battleship, for instance, from a distance of five miles or more. At first rising to a considerable altitude, he volplanes down at terrific speed. On nearing the water, he drives straight for his target and drops his torpedo, which then darts ahead exactly as if launched from a destroyer. The mobility of aircraft makes it possible to circle about a hostile ship and approach it from any side at a speed that makes it an elusive target. A lieutenant of the royal navy made four flights with such a craft over the Sea of Mamora, launching four torpedoes weighing 731 pounds each. The attacks were successful, four Turkish ships being sunk. Since a well-directed torpedo is considered as destructive as a large coast-defense gun, the value of the torpedo-plane is naturally great.

A powerful searchlight is an essential part of the equipment of a war-plane. In landing after a night flight, great care must

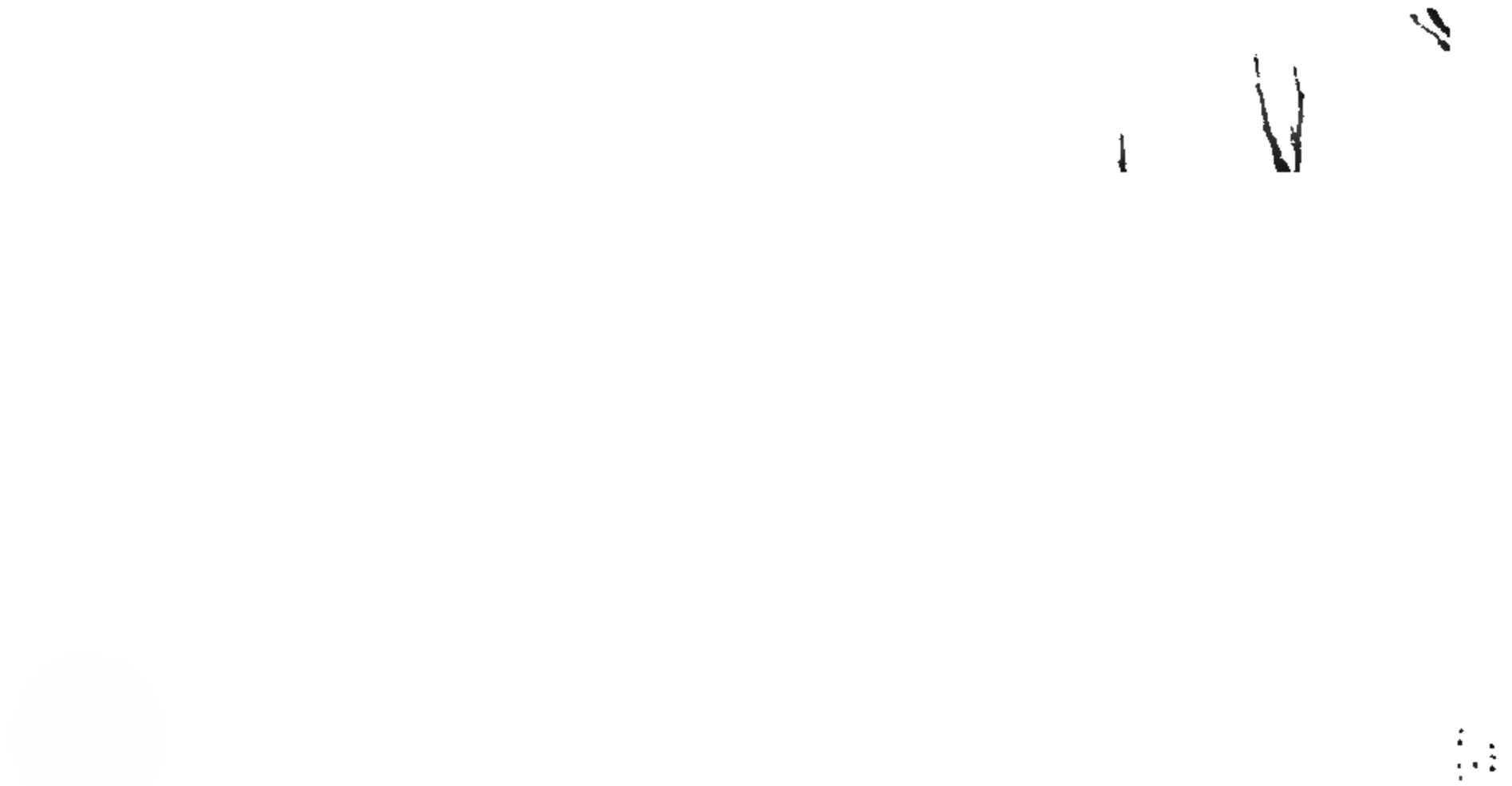
be exercised to avoid attack from the guns alike of friends and enemies. A system of signals was worked out during the famous Verdun campaign which later was generally adopted. No machine is allowed to land until it has first signaled its approach and received the answering signal, "all clear," from below. Since all lights are extinguished or carefully shaded from observation from above, there is great danger that an air man may mistake his landing-place and come down in a hostile camp. When a French pilot reaches what he supposes to be his own aërodrome, he first circles about high in air and signals his special letter in the Morse code by means of his searchlight. He is answered by the ground projectors, and the air man must recognize the password, as it were, before alighting.

In the British squadrons, the pilot nearing his aërodrome burns a light which is answered by a prearranged signal from the ground. The color of the signals tells the man aloft if he may land in safety. Each aërodrome in the vicinity has its own light, so that the air pilot must, of course, be able

to recognize the various signals at a glance. The flare-lights are controlled by the brigade headquarters, and the secret code is as carefully guarded as any password. The air pilot must be on the alert, for the signal may flash out and disappear in a fraction of a second. To burn a signal-light for any length of time might attract the attention of enemy aëroplanes which would direct an artillery or bomb fire upon it.

To meet the peculiar conditions encountered by aëroplanes in flight, two types of wireless-telegraph apparatus have been devised. In observation work, where the air man from a high altitude reports the effect of shell-fire and so assists the gunners of his forces, a twenty-mile range is sufficient. Enough power to operate such a wireless set can readily be supplied by storage batteries. The complete outfit for this work weighs about forty pounds. For long-range work, a set has been devised weighing sixty pounds, which is operated by a two-blade fan. It is mounted on one wing and transmits successfully up to 110 miles.

These sets are usually attached directly



A speedy British war plane

in front of the pilot's seat, within easy reach. By using a fan-driven motor, communication may be kept up as long as the aëroplane travels above a "stalling" speed, and is not affected by any change of speed. A trailing "aërial," made of braided wire which dangles far below the aëroplane, is used in this work. Before landing, this aërial is wound up on a reel beside the pilot's seat. As a precaution, the wire is made very light so that if the aëroplane was forced to land suddenly, giving the operator no time to reel it up, it would readily break. A strong wire aërial, in dragging along the ground, might easily be caught and pull out the strut or other part of the aëroplane to which it was attached.

When the aëroplane carries only a sending apparatus, an ingenious plan is carried out to test its efficiency. A number of test signals are sent out, while the air man circles about high in air. The commander signals back by placing several large, white sheets on the ground in prearranged formation. When an aëroplane is likely to fly out of effective wireless range of its base, car-

rier-pigeons are taken along to bring back reports.

The deafening racket set up by the motors of an aëroplane makes it difficult for the wireless man to receive messages. The wireless operator who "receives" on a rail-road train when in motion, is supplied with a sound-proof room or closet. Aboard an aëroplane, the weight of such an inclosure would, of course, be a serious objection. The operator, instead, wears a metal, sound-proof helmet which completely covers his head and rests on his shoulders, much the same as a diver's helmet. Thus protected, the pilot with his receiver strapped to his head, sits in a sound-proof inclosure and reads the faintest dots and dashes with-out inconvenience. The perfection of this aërial equipment is one of the wonders of the Great War. Under the stimulus of necessity, every detail of the fighting-planes has been developed with unprecedented rapidity. A well-known military authority said recently that three months' development in aërial warfare had been equivalent to a century of development in naval warfare.

CHAPTER VIII

AIR DUELS

THE most fantastic prophecies of aërial warfare have fallen short of the reality. The imagination of Jules Verne or Edgar Allan Poe have failed to conjure up pictures of battles in the sky half so thrilling as the actual encounters of to-day. An air battle is fought with a recklessness and an appalling hazard of life never before known on land or sea.

The first aërial encounters were fought in a comparatively leisurely manner. The antagonists flew toward one another exchanging shots, swept past and returned to the attack, not unlike two knights tilting in a medieval tourney. With the rapid increase in skill and daring of pilots, these air manœuvers were soon changed. A battle is won to-day more by good airmanship than gunnery. Each pilot strives to outmanœu-

ver his opponent and must learn to thrust and dodge with amazing confidence and accuracy. They no longer attack blindly, firing at one another point-blank, like old ships of the line. The fate of an aëroplane is decided rather by one good shot where, in an earlier stage of aërial warfare, many shots would have been wasted.

No air duelist has probably had a more brilliant record for daring airmanship than the German aviator, Captain Boelke. In his brief career, he was matched against hundreds of air men and brought down more than forty aëroplanes. To his antagonists, he seemed to bear a charmed life, and his skill and courage became a fable throughout the armies. Under the pilotage of even the most skilful air man, an aëroplane is unwieldy and requires considerable airway for manœuvering. Let the pilot make an error of judgment, a trifling miscalculation, and the precarious balance may be lost, with death following in an appalling form. In most of these aërial duels, the aëroplanes often approach within a hundred yards of one another, and should they be separated

by but thirty or forty yards, are considered at very close quarters.

In one of the most famous air duels, this time with a French air man, Boelke at a great altitude approached within less than ten feet of his antagonist. The two aëroplanes had been darting about high in air, like swallows. Boelke had fired in all fully five hundred shots at his antagonist, riddling his wings. Finally a shot struck some vital part of the machine, and the French aviator sought escape in flight. It was then that Boelke pressed his advantage, and drove his machine to within less than ten feet of his antagonist's plane. Just at the moment a disastrous collision seemed inevitable, Boelke, with consummate airmanship, turned his machine quickly on its left side, almost grazing his antagonist. At the same instant, the enemy's machine turned over and dropped out of sight.

In another encounter Boelke, after delivering a destructive fire, crept up on his antagonist to observe its effect. On nearing him, Boelke found that the machine had been left to guide itself, the pilot having climbed

ellist preparing for action

An air du

from his seat far out on the left wing of his aëroplane where he stood holding on to one of its supports. A piece of the helm had been shot away and the machine had pitched downward. The only chance the pilot had to balance his aëroplane was to transfer his weight and play this terrifying game of sea-saw high in air. As Boelke swept past, he could see the look of terror on the pilot's face.

A similar accident occurred to Victor Chapman, the American pilot, who managed to escape by an amazing display of pluck. A German bullet had cut away the metal stability-control of his machine, threatening instant collapse. Chapman's machine was already riddled and he had suffered a severe scalp wound. He realized his danger and by a supreme effort succeeded in holding the broken part in place while he steered his craft with his free hand to a safe landing. No aviator had ever before been known to escape after such an accident. Chapman's nerve, however, was unshaken, and after hurriedly repairing his machine and having his wounds dressed, he rose again a few

minutes later to dash into the thick of the fight.

An air pilot can, so to speak, tie the reins which guide his craft by attaching rubber bands to the helm, when the machine will fly for a time unaided. The aviator then has his two hands free to work the gun. After one of his attacks in which Boelke was certain he must have "finished" his opponent, the enemy still continued to fly. Boelke, on approaching cautiously, found the pilot dead, the body being strapped securely to the seat. As long as he continued in sight, the tragic craft, with its engine still driving at top speed, continued to balance itself high in air, rising and dipping to the air currents as it swung round and round in widening circles.

It often happens that an air man, finding himself cut off from all escape, sells his life as dearly as possible in a last desperate attack on his antagonist. A French bombing aëroplane, which had ventured far over the German lines, was once set on fire by a bullet entering the gasolene tank. The pilot knew he would be burned to death before he could

reach the ground, and that but a few moments of life were left him. The observers below saw him turn his craft sharply, and fly directly toward his antagonist. His enemy had no time to escape the collision. The two planes came together with a crash that could be heard on the ground far beneath, and the burning wreckage of the craft fell together.

An accident, without precedent in warfare, occurred to a French bombing plane, and death was averted by a feat of daring which will long be remembered. The aëroplane was about to descend after a raid, when the pilot discovered that two of his bombs had caught in the rigging below the car. It was impossible to land without exploding them and blowing the frail craft to fragments. The gasolene already was running low, and some desperate expedient must be attempted within the next few seconds. While the pilot held his craft to an even keel, the passenger crawled from his seat to the wing, and thence to the rigging below. The bombs must be released with the greatest delicacy to prevent their exploding.

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"Landing" a Zeppelin

Impossible as the feat seemed, it was at last accomplished and the passenger regained his seat in safety.

An aëroplane has often proved itself more than a match for its antagonist in an unequal encounter. A French aviator once penetrated far behind the German lines and chanced upon a heavily laden troop-train. The speed of his craft being fully twice that of this unusual antagonist, it gave him an advantage he was quick to use. The aëroplane flew so low that its machine-gun was brought to bear upon the cars, raking them with disastrous results. Still flying very low, the air man increased his speed and, on coming abreast of the locomotive, shot both engineer and fireman. Left to itself, the locomotive raced forward uncontrolled, and taking a sharp curve at high speed, was wrecked with great loss of life.

In all airmanship there is probably no more difficult manœuver than "shamming a fall," which a pilot may resort to when hard pushed by an enemy. This trick consists in falling from the plane where the battle is in progress for thousands of feet to gain time

and dodge the pursuer. The aëroplane may turn its tail straight up and shoot downward in a spinning nose-dive, or fall in side "stalls" for perhaps a mile, when it suddenly flattens out and makes off at top speed. This bit of strategy usually enables the pilot to gain a few seconds headway, allowing him to make good his escape.

Even routine reports of the aëro-scouts read like the most fantastic fiction. To choose almost at random, take the experience of Lieutenant R. H. Mulock, R.N., a Canadian air man, while patrolling the English coast against Zeppelin night attacks. His aëroplane was armed with bombs, grenades, and a revolver. It was past midnight and a moonless and starless night with scurrying clouds, when a Zeppelin was sighted. It was steering due south, and the aëroplane, laying a course east of south, started to head it off. The Zeppelin was about 2000 feet up and had started to drop bombs, when the aëroplane overtook it. Since its engines were still, the lookout heard the aëroplane coming, located it by flames from its exhaust,

and opened fire with a battery of rapid-fire guns.

The aëroplane was not hit and the Zeppelin now rose quickly, steering out to sea. The scout-plane chased its giant antagonist up to an 8000 foot level and across to the Belgian coast, where both craft flew into the clouds. The aëroplane scout thereupon climbed to 9500 feet, and "rambled around" in search of the "Zepp," but without success. The Zeppelin had probably shut off her engines and after locating the aëroplane by the roar from its propellers, changed its course and escaped. After searching about in the upper level for some time, the scout turned homeward, recrossing the North Sea and steering by compass through the opaque darkness. He had been flying for some time when three powerful searchlights shot up from below, evidently from a British cruiser which had heard his engines. The aëroplane guns of these cruisers, as the pilot well knew, fire at any aircraft at night. He therefore turned and flew for his life. His escape was managed by climbing to a 7500

foot level, and, since night landing is perilous, he loitered around above the North Sea until sunrise, when he could find his way safely home.

The least likely antagonist an aëroplane would be expected to encounter is the submarine. Since one operates far above the sea and the other below its surface, each would seem to be safe from the other's attacks. The aëroplane is, besides, so frail a craft and so vulnerable to any gun-fire, that the sea-craft would seem to have every advantage in any match of strength. Several such encounters have actually taken place, however, which completely upset military prophecies. A French biplane, while scouting near Nieuport one bright day at a two thousand foot elevation, sighted two German submarines. The air man instantly plunged in great circles. The U-boats soon saw their danger and sought to escape. The air man was favored by the fact that the sea hereabouts is comparatively shallow, making it impossible for the under-sea-craft to dive to a safe depth.

One of the U-boats escaped by steaming

A Turkish aëroplane division

The great French air man Pegoud starting on his last flight

at top speed in great zigzags. The aëroplane let it go and turned to the other. It approached its victim in great, swooping circles. Despite frantic efforts, the submarine proved no match in speed for the aircraft. The air pilot selected his position and, at a height of scarcely three hundred feet, let go the first bomb. It struck the target fairly, doing great damage. The submarine was now at the air man's mercy. He circled twice about to gain the best position, and dropped a second bomb which broke the boat fairly in two, sinking it. The first U-boat, meanwhile, had doubtless signaled by wireless for help, so that German aëroplanes might be expected at any moment. Without waiting to attack the remaining boat, the aëroplane climbed to a high altitude and returned at top speed to its base at Dunkirk.

A code of international law governing aircraft remains to be written. In view of the tragic misunderstandings which have occurred over laws governing the sea, it is obviously important that all nations should quickly come to an understanding as to the rights of flying craft. An interesting at-

tempt has already been made to formulate such a code by the Pan-American Conference. It was suggested first that all space above the earth, too high to be utilized by the owner of the ground beneath, be considered public property. All nations are to have sovereign rights to the space dominated by their territories, and all private aëroplanes belonging to citizens and legal residents of a country shall have right of passage through the air above other nations. It is suggested that public aircraft shall have the nationality of the country to which they belong, and that private machines take the nationality of the individual owning them. The hyphenated aëroplane is not provided for as yet. All aircraft should carry distinctive badges of nationality and be officially registered. All nations should "endeavor" not to harm neutrals during warfare, or to restrict their air-commerce. The new code also provides that aëroplanes shall be employed by the Red Cross for errands of mercy.

CHAPTER IX

AMERICAN AIR MEN UNDER FIRE

THE defense of the Mexican border in 1916 offered the first opportunity for active service to the air men of the United States army. On mobilization of the troops, eight tractor biplanes were shipped to the border to accompany the punitive expedition. The aëroplanes had scarcely arrived, however, before their troubles began. Every adverse influence known to air pilots, and some entirely new dangers, were encountered. The desert grows a low bush which proved dangerous to machines in rising and landing. The sand also was soft, and the wheels sank so deeply that it was difficult to get up sufficient speed to leave the ground. The heat, too, played unexpected tricks. The water in the radiators often stood at 120 degrees with the motor at rest. The propellers which had stood the usual

tests at the factories, many times flew to pieces after a few minutes' work in this excessively dry climate. Every part of the machine seemed to deteriorate at an annoying rate.

Once in the air, the aviator's problems increased. The heat of the sun, beating on the desert, started perplexing air-currents which often developed into whirlwinds. Aëroplanes standing at rest would be caught up and overturned. The difficulties of flying under such conditions seemed insurmountable.

American aviators have never before faced these problems. The fighting air men with the European armies have had no such experience, except in flying over the Alps. Some of the mountains crossed in Mexico are 9000 feet in height. Here the air is very thin and treacherous air-currents are encountered which are new to even the most experienced flyers. Many of the daring air men sent up in the Alps on similar flights have never returned.

Within a few hours after their arrival on the Mexican border, the aëroplane division,

A busy day in a balloon factory

nevertheless, had proved its usefulness. The cavalry columns were pushing forward so rapidly into Mexico that General Pershing could only guess at their whereabouts. For days they were beyond the range of wireless and field-telegraph communication. The air men quickly solved the baffling problem of this region, however, by overtaking the advance columns and establishing regular communication with their base. Readers of newspapers at the time of the punitive expedition will probably recall the date-line, "General Pershing's Camp at the Front, via aëroplane to Columbus, New Mexico."

One of the most valuable services of the air men in the Mexican expedition was the maintenance of this daily mail-service between Columbus, N. M., and Colonia Dublan, Mexico, General Pershing's headquarters. It required four days to send the mail by trucks, but the distance of 120 miles was regularly covered by army aëroplanes in sixty-six minutes, while carrying from 250 to 300 pounds of mail.

One of the most remarkable flights of the campaign is credited to Lieutenant Dargue

while on mail-service duty. The start was made at the head of the column at 5:15 A. M. on April 11, a "quartering" wind helping his speed. After flying 200 miles, he came down at one of the stations to deliver despatches and examine his machine. Twenty minutes later, he was again in the air on his way to Columbus. During a great part of the trip, he flew at an elevation of 10,000 feet. He arrived at Columbus at 9:25, covering the 350 miles in 230 minutes.

The record flight in scouting was made a few days later. Despite the bitter cold of the upper regions, the aëroplane quickly rose to 7000 feet which, added to the altitude of Columbus, carried it 11,000 feet above sea-level. Keeping high up to avoid the winds, it flew cross-country for four hours and five minutes. The cold froze the pilot's mustache, and it was only by pounding continuously for half an hour that circulation was restored. On descending, he passed through a wind-storm which rocked the aëroplane so violently that he would have been tossed out had he not been securely lashed to his seat.

It was soon found that the ninety-horse-power aëroplanes of the army were not powerful enough to cross the higher mountain ranges in this region, so that pluck, combined with skilful airmanship, had to be depended upon to solve these problems. The only way an air man could pass a mountain-range was to search out a cañon or pass and wind his way through it. Such flying is extra-hazardous since at one moment the air man will be but a few feet above the ground, and the next may jump off a precipice, finding himself at an altitude of two thousand feet or more. Lieutenant Dargue was crossing the mountains one day, when he flew into a blinding snow-storm which shut out objects even a few yards before him. He had been blown off his course and was completely lost, when a small plateau, just large enough for landing, suddenly loomed up below him. He landed here to find himself 7000 feet up in the mountains. As soon as the snow abated a little, he took the air again and later discovered a village in the mountains where he came down to learn his whereabouts. With the aid of a map

and compass, he oriented and proceeded to wind his way through the mountain passes. After two hours of continuous flying, he came at last to familiar territory.

In flying over an isolated region, especially a desert, the air men face a unique danger. Two or three hours' flight will, of course, carry them as many hundred miles, and should their aëroplanes fail them, they may find themselves hopelessly far from assistance. A flight of five hours can scarcely be retraced in as many days, and the lack of food and water threatens starvation. Two army air men found themselves in just such a plight while attempting a flight over the desert of Sonora, Mexico. The officers, Lieutenant-Colonel Harry G. Bishop and Lieutenant W. A. Robertson, took the air at eight o'clock one morning, intending to cross a mountain-range to the eastward.

The maps followed by the pilots proved inaccurate and the course had to be steered entirely by compass. In order to keep north of the Mexican border, a course was laid twenty-five degrees north of east. It was necessary to rise to an altitude of 7000 feet

to cross the mountains, and in these upper regions a strong wind was encountered. The pilots made no allowance for their drift and soon were far off their course.

The aëroplane was turned southeast at a venture, and after a flight of thirty minutes, a large body of water was sighted. The atmosphere being hazy, the water was mistaken for the Salton Sea. Meanwhile the gasolene supply was running low, and it was decided to search for the tracks of the Southern Pacific railroad which could be followed to safety. The strong wind from the north had not only caused the aëroplane to drift many miles off its course but had greatly increased its speed, so that the pilot was far off his reckoning. After searching for thirty minutes more and flying as many miles, it was decided to land and investigate. Coming down, the aëroplane struck a soft spot, tipped over, and a propeller was broken, putting the machine out of commission. The aëroplane had been aloft for nearly five hours, having covered several hundred miles.

The air men had flown without supplies,

except for a couple of sandwiches and two oranges. The tank of the aëroplane, however, contained a considerable supply of water. An oil-can was filled from the tank, and the soldiers abandoned their machine and started to walk back. Steering by compass, they took a northern course, walking day and night. The food was soon gone but the water lasted several days. Two days later, Lieutenant Bishop grew so weak he could walk no further, and Lieutenant Robertson was obliged to leave him and push on alone.

Meanwhile, several searching parties on foot, in automobiles and aëroplanes had started out to search for the lost air men. As day after day passed without news, it was feared that the men were lost beyond hope. The search was watched anxiously by the entire country. When hope had been almost abandoned, Lieutenant Robertson limped into the camp of one of the searching parties. He had chanced upon the trail of the party, the marks of a corrugated automobile tire upon the sand, and run them down. A party at once set out to

find Lieutenant Bishop and reached him late in the evening of the same day. He was too weak to move, but still conscious. Even with use of automobiles, a day was required to cover the distance which the aëroplanes had traversed in a few hours.

Another army air man, Lieutenant Gorrell, was missing for five days, causing the liveliest anxiety, but finally returned to camp in his own machine. His craft, one of a fleet of aëroplanes which had started out from Columbus, New Mexico, while flying over an uninhabited plateau on the shore of Lake Frederico, became separated from the other planes and lost its way. He had flown many miles, searching for a way out, when his gasolene tank sprung a leak and forced him to land. Without fuel he was, of course, hopelessly marooned. The country was inhabited, as he had seen from aloft, and there was the danger of meeting wild animals or bandits. After walking for six miles, he came across a wagon-trail where he placed a note, tied to a stick, telling of his condition and whereabouts. He then returned to guard his aëroplane. He had had

three days' provisions, but these had been exhausted, and he had been without food for twenty-four hours when a relief party found him. The scouting party luckily carried a supply of gasolene. Lieutenant Gorrell soldered up the tank of his machine and flew back to his base in less than an hour.

The army air men came to the conclusion that scouting, even directly above enemy forces, was comparatively safe. It was estimated that the chances of being hit while flying at high altitude was perhaps one in a million. The aëroplanes were repeatedly under, or should one say, over fire. The air men reported that they could readily see the flashes of the guns trained on them, but that the roar of the propellers drowned the reports, even of the seven-inch guns. The greatest danger encountered was in carrying despatches over mountainous regions while battling with dangerous and unfamiliar air-currents. In one of these flights, Lieutenant Dargue covered 165 miles in two hours and twenty-five minutes. In flying over a mountain pass at a 4000 foot altitude, an eddy caused him to drop suddenly, and he

U. S. Military aëroplanes in Mexico

U. S. Army aëroplane carrying mail to General Pershing in Mexico

only succeeded in righting his machine within fifty feet of the ground.

Several of the air men were severely injured. The experience of Lieutenant T. S. Bowen, who was badly shaken up in a fall at Casas Grandes, illustrates the unexpected dangers encountered by the air-scouts. Bowen's nose was broken and his face was placed in a plaster cast, but he was nevertheless enthusiastic about his work. He had flown sixty-five miles ahead of the advancing column and made valuable observations. Flying at an altitude of 5500 feet, he had reached Ascension without mishap and was nearing Casas Grandes, when the wind became "puffy." By skilful airmanship, he worked his way down to an elevation of but sixty-five feet, when his aëroplane "side slipped," and he came down almost head first. With a desperate effort, he strove to right his machine, and would have succeeded if he had been twenty-five feet higher. The machine was badly smashed and Bowen remained unconscious for half an hour.

One of the narrowest escapes was re-

CHAPTER X

THE CHIVALRY OF THE AIR

IN facing the appalling hazards of aërial warfare the air men of the embattled armies show themselves to be incomparable sportsmen. They fight without rancor, and even when their lives hang in the balance, observe a rigid etiquette. At the beginning of the great war few rules had been laid down to govern aërial encounters. The amazing development of the warplane and of airmanship had not been anticipated by any Hague Conference. Although the dangers of such warfare has increased beyond all precedent the air men on every front have vied with one another in the display of gallantry. During many encounters at terrifying altitudes, where the slightest miscalculation invited instant death, the duelists of the air have refused to take an unfair advantage. The psychology of all this is per-

haps obscure and at times their chivalry seems almost quixotic.

In the ancient etiquette of knighthood, there was no tribute to a fallen foe more chivalrous than the "round of honor" commonly observed to-day among air men. When an antagonist is "driven down," the survivor willingly endangers his life to pay a unique tribute. On the day following the duel, the victor returns and decorates the place where his antagonist fell. His aëroplane may be the target for many batteries of anti-aircraft guns, which mistake his errand, so that he may be obliged to fly at high altitudes, facing adverse air conditions, but the "round of honor," nevertheless, is carefully observed. On reaching the region of the encounter, flowers are thrown out to float gently down to the scene of the tragic landing.

It is astounding to find these duelists of the air sinking all personal animosity in their encounters. The men who meet aloft are often well-known to one another by reputation, perhaps are personal friends. Should both survive the duel and chance to meet afterwards, it is in a spirit of good-comrade-

ship. A desperate encounter took place one day between the famous German aviator Boelke and a Frenchman, in which the French pilot was wounded and forced to descend in German territory. He landed safely, and was instantly made a prisoner of war. The following day Boelke called at the military prison and invited his vanquished foe to lunch with him, when the details of the encounter were recalled with perfect good-nature.

When the great Boelke fell, the news of his death spread quickly. It must have been by some roundabout route that the news reached France which made the promptness of her tribute remarkable. Boelke was credited with having brought down two-score aëroplanes of the Allies in brilliant air-duels, but his good sportsmanship was highly esteemed by his enemies. Within a few hours after his fall, a French aëroplane appeared over his camp and dropped an elaborate wreath with a message of respect. It is part of the etiquette that at such times no trouble be spared in forwarding these tributes.

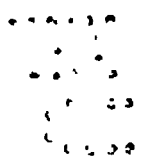
It is understood when an air man is disabled that he may signal his surrender by holding both arms above his head. The steering-control of the aëroplane, meanwhile, may be fixed so that the craft continues to guide itself. On recognizing this signal the air man instantly ceases his attack. To fire on an enemy after such a surrender would be equivalent to firing on a white flag, and it is a point of honor among all air men never to abuse the signal. Even though an air man could save his life with a gesture, by gaining time to escape, the chivalry of the air would not permit him to purchase his life at such a price.

The air men in the eastern theater of war are no less chivalrous. Both the Austrian and Russian aviators are extremely punctilious. When an aëroplane is brought down in the territory of either combatant, it is the duty of the victor to inform the friends of the fallen enemy of his condition. The day following the encounter, the victor flies over the enemy's territory and drops a small bomb in open country to attract attention. He then drops a stone carrying a long

streamer which may be seen from a considerable distance which guides the soldiers to the spot where it falls. Wrapped around the stone will be found a complete statement of the condition of the fallen air man. If he has been killed, the disposition of the body and location of the grave is given, while if he survives, his exact condition is stated and messages may even be sent to his friends. Daily bulletins of his condition may follow.

The parents of a German air man whose home is in New York recently received a touching letter from a French officer announcing with respectful sympathy the death of their son at the front. The writer explained that he had engaged his antagonist at a high altitude somewhere above French territory, and after a spirited air duel had driven him down. The Frenchman had learned his name and the New York address of his parents from papers found in his pockets and wrote to explain that his antagonist had died like a soldier and had been buried with military honors.

Such communications are always ex-



Result of a fall from a low altitude

pressed with formal politeness. There is never a word of insult or abuse. The air men vie with one another in courtesy. At times, either side may permit themselves a little irony, but even then, incredible as it may seem, the letters are written in a spirit of good-natured fun. The air men who have met in perilous encounter several miles in air, actually joke with one another over dangers which might have daunted Cæsar. When the death of a fallen air man is announced, the letter is written with respectful sympathy. To understand this spirit, it must be remembered that the air men are recruited from the best families of the countries engaged, many of them being titled.

A particularly daring Russian raider appeared over Austrian territory one day, and was quickly engaged at a high altitude. After a spirited encounter, the Russian signaled surrender by throwing up his arms, and drifted slowly to earth. When the Austrians below made him prisoner, they were surprised to find him sobbing bitterly. They supposed naturally the Russian had been told he would be treated badly, and has-

tened to reassure him. When he could control his voice, he explained that he was not worried about his treatment, but that on the following day he was to have gone to Petrograd on leave of absence to be married.

Although the country for miles about was devastated, the Austrian officers searched until they found a beautiful bouquet of flowers. On the following day, the victor of the air duel flew above the Russian aviation headquarters and dropped the flowers with a long streamer of silk ribbon. Tied to the flowers was a charming letter addressed to the fiancée of the fallen air man. The message described the brave fight their captive had made, and his courage and loyalty in fighting for his flag. He was unavoidably detained from keeping his appointment at Petrograd, the letter explained, but the lady was assured he was among sympathetic friends who would consider it a point of honor to return him, after the war, safe and sound. The letter was signed by all the officers of the aviation corps. The message reached its destination, and a few days later a Russian air man flew over the Austrian

trenches and dropped a letter in reply from the lady herself. The heroes of pageantry, who fought valiantly for a lady's glove or kerchief, could scarcely have done more.

Invariably, when an air man is brought down and captured, he is paid more than the customary honors of war. He is received as a social equal and often becomes the hero of the camp. One of the first attentions is to assign an orderly to wait upon him, who replaces the valet he probably left at home. The prisoner is established in the best quarters available and granted every personal liberty consistent with his position. It is even common to place an automobile with a chauffeur at his disposal. The prisoner is supplied with books, papers and delicacies. He is visited regularly by his fellow air men and entertained as far as military regulations will permit. His conditional hosts bring photographs and drawings of their aëroplanes, and he discusses the technical points of their machines. There have been many such meetings both on French, German, and Russian soil.

The captors often go to extraordinary

trouble to serve their enforced "guest." Two English air men were once brought down without injury in German territory. By some chance, they had flown that day without their uniforms. The German officers managed in some way to notify the Englishmen's comrades of this fact, and a few hours later a British aëroplane appeared over the German base and dropped packages which contained the proper uniforms with a change of underclothing and toilet articles.

An air man will face serious danger in order to observe punctiliously the letter of the etiquette of the air. In flying before a reviewing officer or some distinguished visitor, it is considered good form to dip the aëroplane by way of salute. Many air men have insisted on carrying out this somewhat dangerous manœuver despite dangerous conditions. During a recent review of the aviation corps in northern France, two aëroplanes found themselves in a crowded course when one pilot, recognizing a superior officer in the approaching craft, risked his life in order to give his superior the right of way.

Above the clouds

THE CHIVALRY OF THE AIR

The chivalry of the air is observed with pride throughout Europe. A friend of the writer chanced to be in a moving-picture theater in Berlin during the war, when a film was shown of the burial of a British air man. The coffin, as a special mark of honor, was borne on the shoulders of German officers. After the customary salute had been fired, the officers of the aviation corps saluted the grave. The special pathos of the scene lay in the fact that the men, all of whom were young and strong, limped badly, for accidents to the legs and feet in landing are common. Each of the officers in turn paused at the open grave, and dropped a rose upon the coffin of the fallen enemy.

The coffin was wrapped in a British flag and at the sight of it, some one in an upper gallery of the theater hissed. Instantly the audience was on its feet in angry protest. A riot was threatened and cries of "throw him out!" were heard on all sides. When the lights were turned on, the ushers found the disturber was merely a boy of fourteen who had no sympathies. The protest had

been perfectly spontaneous. Before the pictures were continued, a lady rose in the audience and, in a touching speech, apologized for the insult. She explained that doubtless there were foreigners present, and hoped that the attitude of the German people would not be misunderstood. She had three sons at the front, she declared, and if they fell, could only hope they would be treated with equal honors.

The same correspondent, before leaving Berlin a few days later, called upon one of the censors to pay his respects and thank him for many courtesies. The official, an old general, on learning that the correspondent was returning to America, asked him to translate a singularly touching letter he had received from an English clergyman informing him that his only grandson, an air man, had fallen and been buried with all the honors of war by British aviators. The English officers had chosen the clergyman, evidently a man of culture, to write to break the news as gently as possible.

The spirit of chivalry is common to the air men of all the embattled armies. Dur-

ing one of the German air-raids upon London, a Zeppelin was brought down, all the crew being killed in the fall. Public feeling against the invaders ran high, and there was a general feeling against burying the dead with military honors. Despite violent opposition, the British aviators insisted that the Germans be buried with all the honors of war. It was due to their efforts that the plans were finally changed, and in the funeral British aviators acted as pall-bearers.

CHAPTER XI

AMERICAN AIR FORCES

TO America belongs the credit of appreciating the value of the aëroplane in warfare, both for the army and navy, and of making, however crudely, its first practical application. The first army flight, and the date is historic, was made near Washington in 1909 by Wilbur Wright in the presence of President Taft and other Government officials. The first naval flight followed two years later. For a brief period the United States enjoyed the distinction of holding the mastery of the air.

While the air fleets of Europe have developed at an amazing rate, it is gratifying to know that some of the most coveted records for flying are still held by United States army and naval aviators. A world's record for altitude was made by Lieutenant Richard C. Saufley, U. S. N., on December 3, 1916,

Looking astern from an aëroplane in flight

An aëroplane returning to its hangar

when he flew in a hydroaëroplane to a height of 12,136 feet, which he bettered on March 29, when he climbed in three hours to 16,700 feet.

The first air men to fly under actual war conditions were also Americans. Several months before the outbreak of the Great War flights were made during the attack on Vera Cruz when two hydroaëroplanes from the Government Station at Pensacola, Florida, accompanied the battleship *Mississippi.* The American officers flew over the territory occupied by the Mexicans for upwards of twenty miles, bringing back valuable information as to the position of the enemy. The amazing development of the fighting air craft in the European War has left the United States far behind as to numbers, but the genius which gave the first aëroplane to the world has merely lain dormant, and is doubtless capable of making America, if the need arises, the first air power.

A complete system of aërial coast defense in America was planned in detail by Rear Admiral Robert E. Peary early in 1915. While to the lay mind some of his sugges-

tions appeared at the time somewhat advanced, the development of aviation had confirmed the wisdom and far-sightedness of his advice. At that date no submarine had crossed the Atlantic, nor was such a journey considered by most people within the range of possibilities. Admiral Peary's plan was in brief to establish an aërial patrol, comprising a chain of aviation stations at intervals of fifty or one hundred miles along our entire coast line. To quote the admiral's own words:

"The seaplanes of the coast patrol will furnish one of the most effective antidotes for the submarine. The patrol is to provide a continuous picket line of seaplanes or flying boats fifty miles or more off shore, round our entire coasts from Eastport, Me., to Brownsville, Tex., and from San Diego, Cal., to Cape Flattery, Wash., each machine traveling back and forth, back and forth over its section or beat, a winged sentinel forming a cordon, a continuous line of whirring shuttles, weaving a blanket of protection around the country.

"The idea is to divide our entire coast

lines into sections of convenient length. Each of these sections and stations will be equipped with four seaplanes. Each of these machines will carry a driver and an observer and be equipped with light wireless apparatus, powerful glasses and a sensitive microphone.

"When in active operation these seaplanes in each section will take their position some fifty or a hundred miles off shore and patrol their respective beats continuously back and forth, in clear weather 2000 feet or more above the sea, from which altitude ships fifty miles distant may be seen. At night or in the fog the seaplanes would, of course, sweep much lower, at all times themselves invisible to an enemy.

"By means of the wireless information as to the character, number and apparent destination of approaching ships will be transmitted to the shore station and from there to Washington. Let us imagine it is war. This advance notice of the approach of the enemy is the first step. In modern warfare hours and even minutes may spell victory.

"The enemy is still unaware that his ap-

proach is known, for the sentinel seaplane was invisible to him. With the next step a cloud of scout seaplanes sweep out in such numbers as to overwhelm and destroy the enemy's aëroplanes, leaving him blinded. Then follow the squadrons of great battle triplanes, each machine carrying several tons of high explosives to drop upon the hostile fleet." Admiral Peary estimates that no less than 2000 hydroaëroplanes are needed on each coast to make such a patrol effective.

There is scarcely any limit to-day to the effective range of aëroplane attacks. The seaplane carriers or mother ships enable aviators to rise from an invading fleet, and after making their raids return to these bases. The submarine may also become a seaplane carrier. There are several forms of aëroplanes with folding wings which could readily be accommodated aboard these under-sea craft. Within a few months the United States has suddenly awakened to this new danger. An invading fleet, for instance, could readily assemble a few miles off our coasts, well out of range of any land bat-

teries, and send powerful raiding fleets to attack our cities.

To prepare for any possible attack three classes of anti-aircraft defense are possible. The first line of defense would be the so-called flying defenses, comprising fast armored fighting seaplanes and armed dirigibles held in instant readiness to fly far out to shoot down or drive away all hostile air craft. A second line of defense will consist of batteries of anti-aircraft guns manned by trained gunners stationed well out to sea along the shore line. A great fleet of swift motorboats with anti-aircraft guns will meanwhile patrol the coast. The third line will consist of formidable batteries of anti-aircraft guns with searchlights and "listening towers." The stationary as well as floating and flying batteries would, of course, be linked together by wireless that they may work effectively together.

The first demonstration of the value of the aërial coast patrol was given in the fall of 1916 during a theoretical attack on New York. A "Mosquito" fleet of fast power boats, aided by an air scout, engaged in a

week's manœuvers to work out the tactical problem of the defense of the harbor. The air men encountered the worst storms of the season, which drove all ordinary craft to shelter, but their observations nevertheless turned the tide of "battle," and the "hostile" fleet was repulsed. Early one morning the torpedo boats *Flusser* and *Warrington* left New York, and after running rapidly down the coast for sixty miles, returned in the rôle of a hostile squadron bent on attack. The *Flusser* led, concealing the main fleet, represented by the *Warrington*, with a screen of smoke. A flying boat, accompanied by a fast launch, the *Dodger II*, acting as mother ship, was detailed to scout along the coast and sight the "enemy" at the earliest possible moment, and signal her base of its approach.

The air scout had scarcely reached the open sea when it ran into a thunder storm, which proved to be the worst of the season. The aëroplane was soon lost in the dark cloud bank, while the mother boat was driven back to shelter in New York Bay. After waiting for some time the return of the air boat, the *Dodger* became alarmed, and hur-

ried out to sea. The alarm was also wirelessed to the *New Jersey,* the flagship of the squadron, and to the destroyers in the vicinity. Late in the afternoon the Atlantic Yacht Club received a telephone message from a life guard at Quogue, Long Island, fifty miles up the coast, that the air pilots had telephoned him from Oak Island, near by, where they had been driven by the storm. The aircraft had kept pluckily to its task in the face of a gale which tossed it about like a chip. By mounting to a considerable altitude it escaped the worst of the wind and managed to weather the gale. It had not retreated, however, until the "enemy" had been sighted, whose position they were able to report. The flight of sixty miles had been made in less than fifty minutes. When the report reached the flagship of the fleet the commander wigwagged back, "Well done."

Scouting aëroplanes have already been used in America for hunting submarines, and have given an excellent account of themselves. An alarm was sent out from Quogue, Long Island, on March 26, 1917, that two U-boats were believed to be off the

Long Island coast. The record of the *U-53* was still fresh in the public mind and the aëronautic authorities at Washington took steps without delay to prove the truth of the report. On the following morning four civilian air men rose from the field at Mineola on this difficult detail. They were ordered to patrol the Long Island coast from Oyster Bay to Montauk Point, while air men from the Aërial Reserve Squadron at Governors Island watched the shore from New York to Oyster Bay.

A forty-mile-an-hour gale was blowing and considerable rain and fog was encountered, rendering the search extremely difficult. The aëroplanes flew out to sea from five to eleven miles, besides thoroughly searching the innumerable bays and inlets along the extended shore line. All vessels observed were plotted and the compass directions and time of location were recorded. One of the aëroplanes flew 124 miles in a driving rain storm. The machines did not carry wireless apparatus, but a cruiser and other vessels could have been summoned in short order if needed. No submarines were

Surface transportation of an aëroplane

discovered, but the efficiency of the aircraft for scouting purposes was clearly established, and the naval authorities announced later their gratification at the promptness and efficiency of the work.

The first encounter of air fleets above American soil occurred in March, 1917. It was a sham battle, to be sure, but the attack and defense was planned by military experts to offer the severest possible test of the airmanship and fighting qualities of our army pilots. An invading squadron of three "armed" scouting aëroplanes was detailed to dash in from the sea and Long Island Sound and attack the United States Signal Corps Aviation Station at Mineola. The "enemy" planned to take photographs of the headquarters, and drop "bombs" upon its hangars, barracks, machine shops, and gasolene storehouses. One of these scouting planes attempted to cut through the aërial blockade from Oyster Bay, a second from the opposite direction, and a third from any point which promised an opening. The defensive air squadron comprised thirteen aëroplanes, each of which was assigned to defend

a certain section at all altitudes. The territory defended comprised ten square miles.

Profiting by the experience of the air fleets in the European War, the pilots carried aloft detailed maps and charts on which were marked the position of church spires, millionaires' homes, and the buildings of the towns in the territory to be attacked and defended. The ground was covered with snow and the temperature at the higher altitudes was near zero, while a high wind tested the staying qualities of the army air men. The "battle" lasted for three hours. Most of the flying was done at speed exceeding one hundred miles an hour. The defending fleet succeeded in holding their air position despite all attacks. The "enemy" finally sought to elude the defense by climbing to an altitude of more than a mile, but the defenders pluckily chased them away from the higher positions and won the engagement.

The army aëro squadrons are frequently sent aloft to search for "enemies" who are theoretically hiding or making their way guardedly across country. Some seventeen aëroplanes were ordered aloft one day near

New York to discover an enemy combat patrol using automobiles, which was reported to be making its way across country from the coast, heading towards the aviation field at Mineola. The enemy, of course, sought to conceal itself by traversing roads where the trees and vegetation offered concealment, and by running at top speed when in an exposed position in the open. So effective was the scouting work that eight of the pilots discovered the automobiles and kept them in sight until they reached the gates of the aviation field. At one point several miles from Mineola the cars were halted by a local policeman and warned against speeding, and even this detail was observed by two of the pilots, who included it in their official reports. Another test consists in having an aviator fly for a considerable distance, land, and hide his machine while a squadron of air pilots is sent out to search for him. The machines are painted a color which will blend with the earth, so that it was practically impossible to see it from a high altitude.

Our aërial defenses have been strengthened by a fleet of dirigible balloons which,

under the direction of the Navy, will patrol the coast line and harbors. Contracts were awarded on March 12 to four American firms for the construction in rush time of sixteen balloons of the non-rigid type to be available by the middle of June, or within 120 days. The balloons were finished in 90 days, and have given a good account of themselves. They measure 160 feet in length, 31 feet in diameter, and are equipped with 100 horsepower motors capable of driving them at a speed of forty-five miles an hour for sixteen hours. The scouting dirigibles operate from shore bases and alight on the surface of the water in good weather.

During the present year the number of Government schools for training aviators has been rapidly increased. Several private training schools have also been taken over by the Government so that at present air men are being trained in all parts of the country. Schools are at present in active operation at Mineola, Long Island; Philadelphia; San Antonio, Texas; Fort Omaha, Nebraska; San Diego, California; Columbus, New Mexico; Ashburn Field, Chicago; Newport News,

Distributing literature by aëroplane

Virginia; Pensacola, Florida; Essington, Pennsylvania; Wilmington, Delaware; Squatum, Massachusetts; Miami, Florida; Lake Worth; Palm Beach, Florida; Newport, Rhode Island, and Bayshore, Long Island. Several other schools will doubtless be opened in the near future. The amazing popularity of flying is attested by the fact that over 30,000 American youths have recently made application to enter the service. Special aviation corps have been organized in many colleges and universities throughout the country. At the present rate of training there will soon be several thousand skilled pilots in the various colleges who will be available in case of need. Special provision has been made by the Army for examining these "student flyers" and transferring them if needs be to the Naval Reserve Flying Corps.

A bill was presented in Congress early in 1916 to create a Department of Aviation, whose secretary should occupy a seat in the President's cabinet. According to the plan the new department comprises a Secretary, an assistant secretary, and the necessary cen-